Final

Feasibility Study Addendum
Operable Unit 3A
Installation Restoration Program Site 8

FORMER MARINE CORPS AIR STATION
EL TORO, CALIFORNIA

February 2006

Prepared for:
Base Realignment and Closure
Program Management Office West
San Diego, California

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Prepared under:
Naval Facilities Engineering Command
Contract Number N62742-94-D-0048
Contract Task Order 0068

EXECUTIVE SUMMARY

This report is an addendum to the feasibility study (FS) report for the Installation Restoration Program (IRP) Site 8 (Defense Reutilization and Marketing Office [DRMO] Storage Yard) located at the former Marine Corps Air Station (MCAS) El Toro, California. The original FS for Site 8 (performed in 1997) evaluated potential remedial alternatives to address non-radioactive constituents of potential concern (COPCs) at Units 1, 2, 3, 4, and 5 of the site (BNI 1997a). This FS addendum presents the results of detailed analysis of alternatives for remediation of radioactive COPC (radium-226 [Ra-226]) at Units 1 and 4 of IRP Site 8. The results of this analysis will be used as the basis for selection of appropriate remedy for Ra-226 contaminated soil.

This report was prepared for the Base Realignment and Closure, Program Management Office West and Southwest Division, Naval Facilities Engineering Command (abbreviated as NAVFAC EFD Southwest or NFECSW SDIEGO; formerly abbreviated as SWDIV) as authorized by the U.S. Navy, Pacific Division, Naval Facilities Engineering Command (NAVFAC Pacific) under contract task order (CTO) no. 0068 of the Comprehensive Long-Term Environmental Action Navy (CLEAN) II program, contract number N62742-94-D-0048. It complies with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended by the Superfund Amendments and Reauthorization Act of 1986, and the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) in Title 40 of the Code of Federal Regulations (C.F.R.) Part 300 (40 C.F.R. Part 300).

ES.1 FS ADDENDUM APPROACH

The primary purpose of this FS Addendum is to ensure the development and evaluation of appropriate remedial alternatives so that relevant information concerning the remedial action options is available for selection of an appropriate remedy for Ra-226 contaminated soil. Following general steps were followed to achieve this purpose:

1. Development of conceptual site model (CSM) that summarizes site background, nature of the release, environmental media impacted, fate and transport of constituent of potential concern (COPC) (i.e., Ra-226) in the environment, potential receptors and exposure pathways, and risk assessment.
2. Development of remedial action objectives (RAOs) for Ra-226 contaminated soil.
3. Development of general response actions (GRAs) (e.g. containment, excavation and treatment) that may be taken to satisfy the RAOs
4. Delineation of target remediation zones to which GRAs might be applied
5. Identification and evaluation of technologies and process options applicable to each GRA on the basis of their effectiveness to achieve the RAOs, technical and administrative implementability, and cost.
6. Assembling the selected representative technologies and process options corresponding to different GRAs to develop range of remedial alternatives from those involving complete removal of Ra-226 contaminated soil posing unacceptable risk to human health to those involving little or no treatment but providing protection to human health by minimizing unacceptable exposure to Ra-226.
7. Performing detailed analysis of remedial alternatives based on the following nine evaluation criteria identified in the NCP (40 C.F.R. § 300.430 [e][9][iii]):
    - Overall protection of human health and the environment
    - Compliance with applicable or relevant and appropriate requirements (ARARs)

- Long-term effectiveness and permanence
- Reduction of toxicity, mobility, or volume through treatment
- Short-term effectiveness
- Implementability
- Cost
- State acceptance
- Community acceptance

8. Performing comparative analysis of alternatives for each of the nine NCP evaluation criteria to identify the relative advantages and disadvantages of each alternative.

A summary of the results of the above-mentioned steps is presented in the following sections.

ES.2 CONCEPTUAL SITE MODEL

ES.2.1 Site Background

MCAS El Toro is situated in south-central Orange County, California, approximately 8 miles southeast of Santa Ana and 12 miles northeast of Laguna Beach. Site 8 is located in the southwest quadrant of former MCAS El Toro. Site 8 was formerly a DRMO storage area for containerized liquids, and scrap and salvage materials from former MCAS El Toro and former MCAS Tustin. The scrap materials included mechanical and electrical components and various types of liquids.

Site 8 comprises two distinct but adjacent areas bisected by R Street: an old salvage yard and a main storage yard. These two areas are subdivided into the following five separate units:

- Unit 1, East Storage Yard
- Unit 2, West Storage Yard
- Unit 3, Refuse Pile Area (the location of a former refuse pile within the West Storage Yard)
- Unit 4, PCB Spill Area (located within the east storage yard)
- Unit 5, Old Salvage Yard

Units 1 and 4 are located in the eastern portion of the main storage yard and constitute an area approximately 265 feet by 230 feet (61,000 square feet). Approximately, 90 percent of this area (54,900 square feet) consists of gravel and bare soil, and the remaining 10 percent (6,100 square feet) consists of an asphalt-paved surface.

ES.2.2 Nature and Extent of Ra-226 Contamination

Ra-226 is the radionuclide of potential concern at Units 1 and 4 of Site 8. The exact source and mechanism of release of Ra-226 at Site 8 are not known. However, the Historical Radiological Assessment (HRA) and information on historical Station operations indicate that potential sources of Ra-226 include Ra-226 painted parts, gauges, dials and markers. Since the potential sources of Ra-226 are from storage of Ra-226 painted parts, gauges, dials, and markers, release of Ra-226 is likely to be restricted to the shallow soil (less than 18 inches below ground surface [bgs] approximately).

On-site radiological scan surveys and soil sampling were conducted at Units 1 and 4 of Site 8 in June through November 2001 to assess the distribution of Ra-226 in the shallow soil. A site-specific release level, also known as the derived concentration guideline level (DCGL) (in accordance with the Multi-Agency Radiation Survey and Site Investigation Manual [MARSSIM] [EPA 2000]) of 1 pico-Curie per gram (pCi/g) above background was established for Site 8. The background soil concentration for former MCAS El Toro was estimated to be 1.05 pCi/g. Using a DCGL of 1 pCi/g above background, the Ra-226 site-specific release limit for the Station was set at 2.05 pCi/g.

The analysis of the scan survey data indicated that of the total of 89,356 high density scan survey readings, 394 data points were observed to exceed the approximate scan survey DCGL. Of the 16 soil samples collected, 15 samples contained Ra-226 concentrations greater than 1 pCi/g above background. The concentrations of Ra-226 in these samples ranged from 7.5 to 329 pCi/g, and averaged 95.98 pCi/g.

ES.2.3 Ra-226 Fate and Transport

Radium is readily adsorbed by the soil and is usually not a mobile constituent in the environment. This behavior coupled with low mean annual rainfall (12.2 inches per year) and low average infiltration (less than 5 inches per year) at Site 8, suggests that there is a limited potential for mobilization of Ra-226 by surface water runoff and soil infiltration. However, risk exists for mobilization of Ra-226 in the soil at Site 8 by wind erosion and fugitive dust, since Units 1 and 4 of Site 8 consist of gravel and bare soil.

ES.2.4 Summary of Risks due to Ra-226

Screening level risk and dose assessments were conducted to quantify human health effects associated with exposure to Ra-226 at Units 1 and 4 of Site 8. The risk screening consisted of calculation of incremental risk to a residential receptor due to exposure to average concentration of Ra-226 above background, using the Environmental Protection Agency's (EPA's) PRG Calculator for radionuclides. The dose assessment was conducted by calculating the total effective dose equivalent (TEDE) for a residential receptor based on the average Ra-226 concentration above background in the soil samples, using the U.S. Nuclear Regulatory Commission (NRC) dose assessment software, Decommissioning and Decontamination (DandD) Version 2.1.0.

For soil with an incremental Ra-226 concentration of 94.93 pCi/g (95.98 pCi/g minus 1.05 pCi/g), the DandD software yielded a TEDE of 3,800 millirems per year (mrem/y) using default exposure pathways and parameters for a residential scenario. This TEDE exceeds the NRC dose criteria of 25 mrem/y for unrestricted reuse. Incremental risk above background corresponding to the soil Ra-226 concentrations of 94.93 pCi/g and residential scenario was estimated to be approximately 7.7E-03, which exceeds the NCP defined risk range of 10^{-6} to 10^{-4}.

ES.3 Remedial Action Objectives

Based on the medium of concern, COPCs, potential exposure pathways, and potential ARARs, the following RAOs were developed for remediation of Ra-226 at Units 1 and 4 of Site 8:

- Reduce potential exposure to incremental concentrations (above naturally occurring background levels) of Ra-226 such that residual carcinogenic risk (above background) is in the NCP defined risk management range (10^{-6} to 10^{-4}).
- Reduce potential exposure to incremental concentrations (above naturally occurring background levels) of Ra-226 to achieve compliance with NRC standards for protection against radiation, specified in 10 C.F.R. Sections 20.1402 and 20.1403, such that the total

effective dose equivalent (TEDE) (above background) does not exceed 25 mrem/y and that the residual radioactivity (due to Ra-226) has been reduced to levels that are ALARA.

Risk and dose modeling, and ALARA analysis were performed to develop a target cleanup goal and derived concentration guideline level (DCGL) for Ra-226 that achieves the above RAOs. These evaluations concluded that a target cleanup goal and DCGL for Ra-226 of 1 pCi/g above background results in a risk within the acceptable NCP risk range of 10^{-6} to 10^{-4}, a dose of less than 25 mrem/y, and is ALARA.

ES.4 DEVELOPMENT OF REMEDIAL ALTERNATIVES

To satisfy the above-mentioned RAOs, the following alternatives were identified:

- Alternative 1: No Action
- Alternative 2: Asphalt Cap Plus Institutional Controls and Access Restrictions
- Alternative 3: Excavation and Off-site Disposal

ES.4.1 Alternative 1: No Action

The inclusion of the no-action alternative is required under the NCP (40 C.F.R. § 300.430 [e][6]) to act as a baseline condition for assessing other alternatives.

ES.4.2 Alternative 2: Asphalt Cap Plus Institutional Controls and Access Restrictions

Alternative 2 includes construction of an asphalt cap in the central and northeastern parts of Unit 1 to reduce exposure to Ra-226 contaminated soil. The cap will prevent contact with the Ra-226 contaminated soil, provide shielding against gamma radiation and will also act as a barrier to confine and reduce emanation of radon. Institutional controls consisting of land-use restrictions will also be implemented to ensure the integrity of the cap and limit exposure to future landowner(s) and/or user(s).

ES.4.3 Alternative 3: Excavation and Off-site Disposal

Alternative 3 would include excavation of soil at Units 1 and 4 so that the residual Ra-226 concentrations do not exceed the release criteria established based on the RAOs. The excavated soil will be disposed at a commercial facility licensed to receive Ra-226 contaminated soil. A target cleanup goal and DCGL of 1 pCi/g above background has been established for Ra-226. This target cleanup goal was established based on risk and dose modeling, and ALARA analysis. The risk and dose evaluation indicated that a Ra-226 concentration of 1 pCi/g above background satisfies the NRC dose criteria of 25 mrem/y and results in a risk within an acceptable NCP risk range of 10^{-6} to 10^{-4}, for a residential (unrestricted release) scenario. Additionally, based on the cost-benefit analysis this concentration of Ra-226 is ALARA.

The exposure pathway modeling using RESRAD Build computer code estimated that the site-specific cleanup goal for Ra-226 of 1 pCi/g above background results in a radon decay product concentration of 0.0002 WL for a habitable building, which is less than the limit (0.02 WL) stipulated in 40 C.F.R. § 192.12(b)(1). The modeling also estimated the Ra-226 concentration of 1 pCi/g above background will result in gamma radiation level of 1.2 microroentgens per hour, which is less than the limit (20 microroentgens per hour) stipulated in 40 C.F.R. § 192.12(b)(2).

ES.5 RESULTS OF COMPARATIVE ANALYSIS OF ALTERNATIVES

A comparative analysis of remedial alternatives was performed to assess the relative performance of each alternative with respect to nine NCP evaluation criteria. The results of this evaluation are presented in Table ES-1 and are summarized in the following bullets:

- Alternative 1 is not protective of human health since it does not reduce exposure or potential migration of Ra-226 at Units 1 and 4 of Site 8. Alternative 2 is moderately protective of human health since it prevents direct contact with contaminated soil as long as the cap integrity is not compromised. Alternative 3 is considered fully protective of human health since it involves removal of Ra-226 contaminated soil posing unacceptable risk to human health.
- Alternative 1 will not comply with any ARARs because no remedial action will be taken. Both Alternatives 2 and 3 will comply with all the identified ARARs.
- Alternative 1 will have very little long-term effectiveness because it includes no remedial action. Alternative 2 will be moderately effective in the long term because it does not represent a permanent solution and inadvertent exposure of on-site receptors to Ra-226 cannot be entirely eliminated. Alternative 3 offers high long-term effectiveness and is considered a permanent solution since the contaminants in shallow soil are physically removed from Units 1 and 4 of Site 8.
- Alternative 1 provides no appreciable reduction in toxicity, mobility, or volume of Ra-226 because no remedial actions will be taken. Alternative 2 does not reduce toxicity or volume beyond the slight long-term changes resulting from radioactive decay. However, capping will reduce mobility of Ra-226 via wind or surface water erosion. Under Alternative 3, the contaminated soil will be physically removed from Units 1 and 4 of Site 8; therefore, toxicity to on-site receptors and mobility of Ra-226 at the site will be substantially reduced.
- There is no short-term effectiveness associated with Alternative 1 since no remedial activities are performed. Alternative 2 provides better short-term effectiveness compared to Alternative 3. The cap construction activities associated with Alternative 2 will cause minor disturbance of the contaminated soil compared to excavation and earth-moving activities associated with Alternative 3. Therefore, Alternative 2 poses lesser risk of exposure to site-workers and surrounding communities compared to Alternative 3.
- There are no implementability issues associated with Alternative 1 since no action will be taken. Both Alternative 2 and Alternative 3 include implementation of well-known technologies that can be readily implemented using widely available commercial services, materials, and equipment.
- No cost is associated with Alternative 1. The estimated total present value of Alternative 2 is $664,000. The estimated total present value of Alternative 3 is $1,702,000.

Table ES-1: Comparative Analysis of Alternatives

Criterion	Alternative 1– No action	Alternative 2: Asphalt Cap Plus Institutional Controls and Access Restrictions	Alternative 3: Excavation and Off-site Disposal
Overall Protection of Human Health and the Environment	Low Does not protect human health and the environment against exposure to contaminated soil.	Moderate Provides protection to human health and the environment provided the cap is not disturbed.	High Provides protection to human health and the environment by removing the contaminated soil from the site.
Compliance with ARARs	Low	High Complies with all the identified ARARs	High Complies with all the identified ARARs
Long-Term Effectiveness and Permanence	Low Not effective in protecting human health and the environment. No reduction in risk.	Moderate Contaminated soil is not removed, but is covered with an asphalt cap. Provides protection to human health and the environment provided the cap is not disturbed.	High Contaminated soil is removed from the site. Significantly reduces risk at the site and is considered permanent solution.
Reduction in Toxicity, Mobility, and Volume Through Treatment	Low Does not reduce toxicity, mobility, or volume.	Moderate Reduces mobility, but does not address toxicity or volume.	High Reduces mobility and volume of contaminated soil by excavation and off-site transportation. Does not address toxicity.
Short-Term Effectiveness	High No short-term effectiveness associated with this alternative since no remedial actions are performed.	Moderate Capping activities will cause only minor disturbance to the site resulting in low risk to workers and the public.	Low Excavation activities may expose workers to site contamination.
Implementability	High No implementability issues associated with this alternative since no actions are performed.	Moderate Capping activities will require moderate amount of technical and administrative effort. Institutional controls will require some additional administrative effort.	Moderate Excavation and off-site disposal activities will require average technical and administrative effort.
Cost ($)	None No cost	Low The least expensive alternative.	Moderate More expensive than Alternative 2.
State Acceptance	Will be evaluated following State review of the Final FS Addendum.	Will be evaluated following State review of the Final FS Addendum.	Will be evaluated following State review of the Final FS Addendum.
Community Acceptance	Will be evaluated following public review of the proposed plan.	Will be evaluated following public review of the proposed plan.	Will be evaluated following public review of the proposed plan.

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APPENDIXES

FIGURES

TABLES

ACRONYMS AND ABBREVIATIONS

ALARA	as low as reasonably achievable
Am-241	Americium-241
ARAR	applicable or relevant and appropriate requirements
BCT	BRAC Cleanup Team
bcy	bank cubic yards
bgs	below ground surface
BMP	best management practice
BNI	Bechtel National, Inc
BRAC	Base Realignment and Closure
Cal/EPA	California Environmental Protection Agency
Cal-OSHA	California Occupational Safety and Health Administration
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
C.F.R.	Code of Federal Regulations
CLEAN	Comprehensive Long-Term Environmental Action Navy
Co-57	Cobalt 57
Co-60	Cobalt 60
COC	contaminants of concern
COPC	constituents of potential concern
cpm	counts per minute
CSM	conceptual site model
CTO	contract task order
DandD	Decommissioning and Decontamination
DCGL	derived concentration guideline level
$DCGL_w$	derived concentration guideline level – average over a large area
DHS	Department of Health Services
DON	Department of the Navy, United States
DRMO	Defense Reutilization and Marketing Office
DTSC	Department of Toxic Substances Control
EPA	Environmental Protection Agency, United States
FS	feasibility study
GPS	global positioning system
GRA	general response actions
H-3	Hydrogen-3
HRA	Historical Radiological Assessment
IC	institutional controls
IRP	Installation Restoration Program
JEG	Jacobs Engineering Group
Kr-85	Krypton 85
LLW	low-level radioactive waste
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual
MCAS	Marine Corps Air Station
MDC	minimum detectable concentrations
mrem	millirem
mrem/y	millirems per year
NaI	sodium iodide
NAVFAC	Naval Facilities Engineering Command
NAVFAC EFD Pacific	Naval Facilities Engineering Command, Engineering Field

	Division Pacific
NCP	The National Oil and Hazardous Substances Pollution and Contingency Plan
NFA	no further action
NFECP PEARL	Naval Facilities Engineering Command, Pacific
NFECSW SDIEGO	Naval Facilities Engineering Command, Southwest
NRC	Nuclear Regulatory Commission, United States
OU	operable unit
PACNAVFACENGCOM	Pacific Division Naval Facilities Engineering Command
PAH	polynuclear aromatic hydrocarbon
PCB	polychlorinated biphenyl
pCi/g	pico-Curie per gram
PRG	preliminary remediation goal
Ra- 226	radium 226
RACER	Remedial Action Cost Engineering Requirements
RAO	remedial action objective
RBC	residential risk-based concentrations
RCRA	Resource Conservation and Recovery Act
RI	remedial investigation
ROD	record of Decision
SCAQMD	South Coast Air Quality Management District
SEA	site evaluation accomplished
SVOC	semivolatile organic compound
TAL	target analyte list
TEDE	total effective dose equivalent
Th-232	Thorium-232
TPH	total petroleum hydrocarbons
TRPH	total recoverable hydrocarbons
UMTRCA	Uranium Mill Tailings Radiation Control Act
U.S.	United States
U.S.C.	United States Code
VOC	volatile organic compounds
WL	working level

1. INTRODUCTION

This report is an addendum to the feasibility study (FS) report for the Installation Restoration Program (IRP) Site 8 (Defense Reutilization and Marketing Office [DRMO] Storage Yard) located at the former Marine Corps Air Station (MCAS) El Toro, California. The original FS for Site 8 (performed in 1997) evaluated potential remedial alternatives to address non-radioactive constituents of potential concern (COPCs) at Units 1, 2, 3, 4, and 5 of the site (BNI 1997a). This FS addendum presents the results of detailed analysis of alternatives for remediation of radioactive COPC (radium-226 [Ra-226]) at Units 1 and 4 of IRP Site 8. The results of this analysis will be used as the basis for selection of appropriate remedy for Ra-226 contaminated soil.

The following guidance were extensively used for preparation of this FS Addendum:

- *Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA, Interim Final* – United States (U.S.) Environmental Protection Agency (EPA) Guidance (EPA 540-G-89-004) (EPA 1988).
- *Technology Screening Guide for Radioactively Contaminated Sites* – EPA Guidance (EPA 402-R-96-017) (EPA 1996)
- *Department of the Navy Installation Restoration Program Manual (Draft), 2001 Update* (DON 2001).
- *Technical Report, Guidance for Optimizing Remedy Evaluation, Selection, and Design, Draft Final* – Naval Facilities Engineering Command (NAVFAC) Guidance (NAVFAC 2004)
- The National Oil and Hazardous Substances Pollution Contingency Plan (NCP) (Title 40 of the Code of Federal Regulations [C.F.R.] Section [§] 300.430 [40 C.F.R. § 300.430]).

This report was prepared for the Base Realignment and Closure, Program Management Office West and Southwest Division, Naval Facilities Engineering Command (abbreviated as NAVFAC EFD Southwest or NFECSW SDIEGO; formerly abbreviated as SWDIV) as authorized by the U.S. Navy, Pacific Division, Naval Facilities Engineering Command (NAVFAC EFD Pacific) under contract task order (CTO) no. 0068 of the Comprehensive Long-Term Environmental Action Navy (CLEAN) II program, contract number N62742-94-D-0048. It complies with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended by the Superfund Amendments and Reauthorization Act of 1986, and the NCP in 40 C.F.R. Part 300.

1.1 PURPOSE AND ORGANIZATION OF REPORT

The FS report for Site 8 was prepared in 1997 to develop and evaluate alternatives for the polynuclear aromatic hydrocarbon (PAH)- and polychlorinated biphenyl (PCB)-contaminated soil at Units 1, 2, 3, 4, and 5 of the site (BNI 1997a). However, subsequent to the preparation of the FS and Draft Record of Decision (ROD) (DON 1999a), Ra-226 was identified at concentrations posing unacceptable risk to human health at Units 1 and 4 of Site 8. The primary purpose of this FS Addendum is to ensure the development and evaluation of appropriate remedial alternatives so that relevant information concerning the remedial action options is available for selection of an appropriate remedy for Ra-226 contaminated soil. This report has been organized into the following sections to satisfy this purpose:

- *Section 1: Introduction* – This section presents the purpose of the FS Addendum, guidance documents used for its preparation, and organization of the report.

- *Section 2: Conceptual Site Model* – This section presents a conceptual site model (CSM), including site background, potential sources and mechanisms for release of Ra-226, environmental media impacted, fate and transport of Ra-226 in the environment, potential receptors and exposure pathways, and screening level risk and dose assessments.
- *Section 3: Identification and Screening of Technologies* – This section presents remedial action objectives (RAOs) including identification of applicable or relevant and appropriate requirements (ARARs), and identification and screening of potential technologies to satisfy RAOs.
- *Section 4: Development of Alternatives* – This section presents development of remedial action alternatives by assembling potentially applicable technologies, and provides detailed explanation of alternatives.
- *Section 5: Detailed Analysis of Alternatives* – This section presents a detailed evaluation of alternatives with respect to the nine evaluation criteria specified in the NCP (40 C.F.R. § 300.430[e][9][iii]) to address statutory requirements and preferences of the CERCLA.

2. CONCEPTUAL SITE MODEL

A thorough understanding of the site is required to develop and evaluate appropriate alternatives for remediation of a site. This can be accomplished through development of an accurate CSM. The CSM is an engineering management tool that summarizes site background, nature of the release, environmental media impacted, fate and transport of COPCs in the environment, potential receptors and exposure pathways, and risk assessment. Each of these individual elements of the CSM for Units 1 and 4 of Site 8 are described in the following sections.

2.1 SITE BACKGROUND

2.1.1 Site Description

2.1.1.1 MCAS EL TORO LOCATION AND BACKGROUND

MCAS El Toro is situated in south-central Orange County, California, approximately 8 miles southeast of Santa Ana and 12 miles northeast of Laguna Beach (Figure 2-1). Former MCAS El Toro provided material and support for Marine Corps aviation activities until Station was closed in July 1999, as a part of the Base Closure and Realignment (BRAC) Act. At its maximum acreage, the base comprised about 4,740 acres. In 1998, approximately 25 acres in the southeastern portion of the Station were transferred to the California Department of Transportation. In 2001, approximately 901 acres in the northeast portion of the base were transferred to the Federal Aviation Administration. In February 2005, approximately 3,700 acres were sold via public auction to a private developer. In July 2005, with the close of escrow, approximately 2,798 acres were transferred by deed and 921 acres are being leased pending completion of environmental investigations and response actions. IRP Site 8 lies within the leased portion of the former Station. The remaining 74 acres of the former base associated with IRP Site 1 are still under DON's ownership.

2.1.1.2 HISTORICAL LAND USE AT FORMER MCAS EL TORO

Historical land uses for former MCAS El Toro are described below for the following four quadrants, as defined by the bisecting north-south and east-west runways.

- The northwestern quadrant consisted of former MCAS El Toro headquarters, administrative services, family and bachelor housing, and community support services.
- The northeastern quadrant consisted of Marine Aircraft Group Activities (e.g., training maintenance, supply and storage, and airfield operations), family housing, community support services, and ordnance storage areas isolated by topographic relief and distance from other developments.
- The southeastern quadrant consisted of administrative services, maintenance facilities, ordnance storage, and golf course.
- The southwestern quadrant consisted of aircraft maintenance facilities, supply and storage facilities, and limited administrative services.

Historically, land use around former MCAS El Toro has been largely agricultural. However, land to the south, southeast, and southwest has been developed over the past 10 to 15 years for commercial, light-industrial, and residential uses. Currently, expanding commercial areas adjoin the Station and additional residential areas are located to the northwest and west. Adjacent land to the northeast and northwest is used for agriculture.

2.1.1.3 SITE 8 LOCATION AND BACKGROUND

Site 8 is located in the southwest quadrant of former MCAS El Toro, and is bounded by South Marine Way to the northeast, Q Street to the northwest, Building 360 to the southwest, and Building 800 to the southeast (Figure 2-1 and Figure 2-2). Site 8 was formerly a DRMO storage area for containerized liquids, and scrap and salvage materials from former MCAS El Toro and former MCAS Tustin. The scrap materials included mechanical and electrical components and various types of liquids.

Site 8 comprises two distinct but adjacent areas bisected by R Street: an old salvage yard and a main storage yard. These two areas are subdivided into the following five separate units:

- Unit 1, East Storage Yard
- Unit 2, West Storage Yard
- Unit 3, Refuse Pile Area (the location of a former refuse pile within the West Storage Yard)
- Unit 4, PCB Spill Area (located within the east storage yard)
- Unit 5, Old Salvage Yard (JEG 1993)

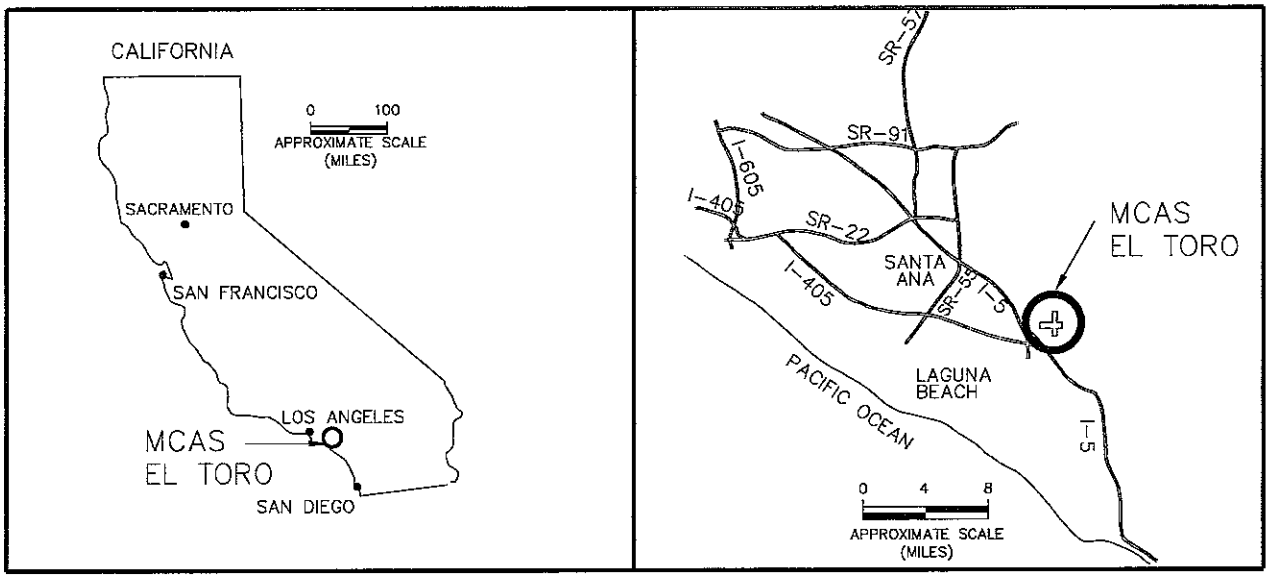
Units 1 and 4 are located in the eastern portion of the main storage yard and constitute an area approximately 265 feet by 230 feet (61,000 square feet). Approximately, 90 percent of this area (54,900 square feet) consists of gravel and bare soil, and the remaining 10 percent (6,100 square feet) consists of an asphalt-paved surface (see Figure 2-2).

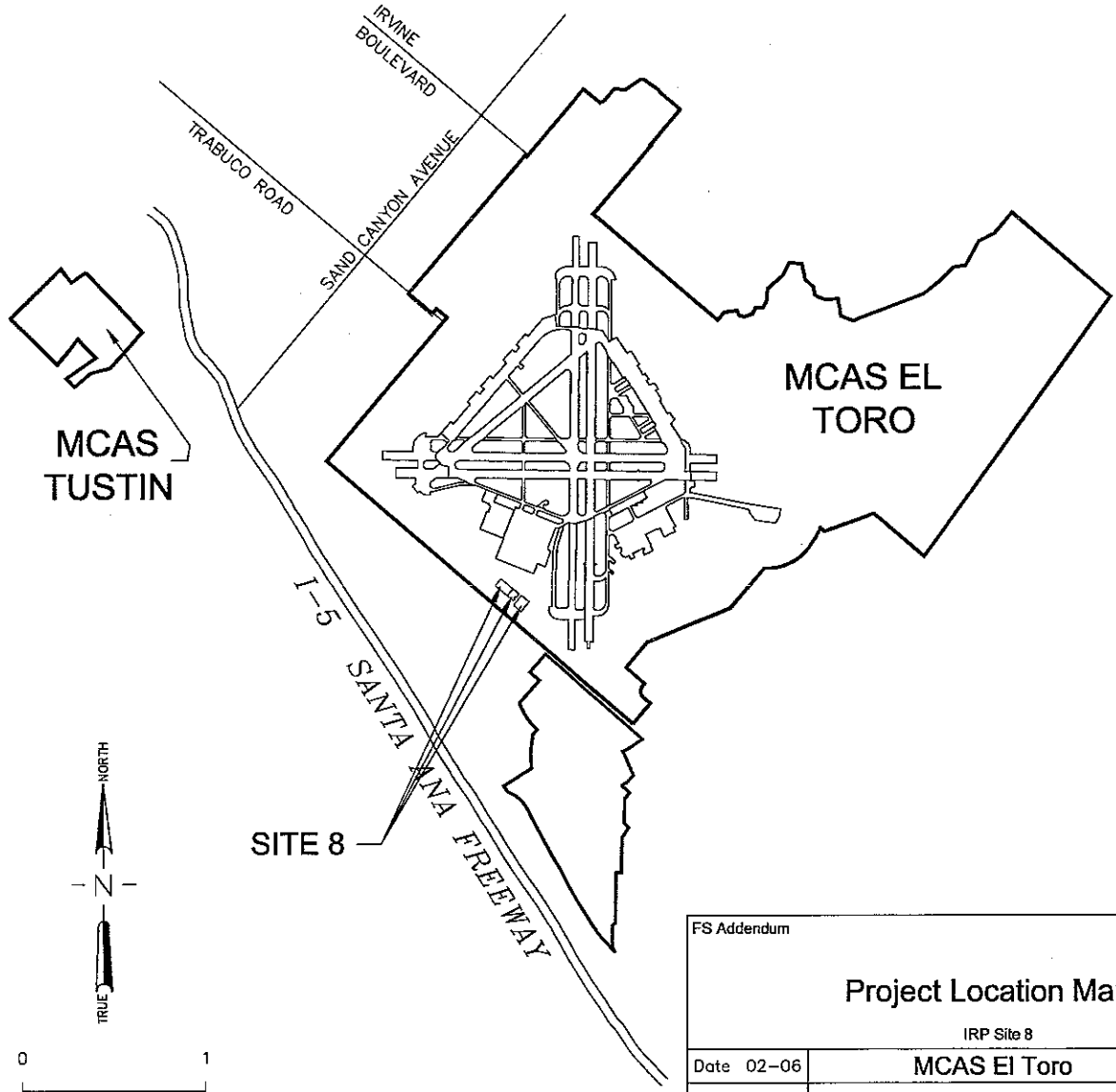
2.1.1.4 SITE 8 LAND USE

Following the closure of former MCAS El Toro, the DON finalized an Environmental Impact Report/Environmental Impact Study in March 2002 to evaluate several alternatives for the reuse of the Station. The DON is in the process of conveying portions of the former station through public sale to private developers. As part of the sale and transfer process, the DON prepared an Environmental Baseline Survey (Earth Tech 2003) documenting the environmental condition of the property. In addition, a Finding of Suitability to Transfer (Earth Tech 2004a) and a Finding of Suitability for Lease (Earth Tech 2004b) were prepared to document which portions of the Station are available for transfer and lease, respectively. A conceptual reuse plan titled the "Great Park" has been proposed; this plan calls for mixed reuse with residential, commercial and recreational/open space uses. Based on this plan, IRP Site 8, located, within sale Parcel 3, is in an area proposed for institutional use.

2.1.2 Site History

Site 8 was used as a storage yard from the early years (late 1940s) of the Station operation. During its operation as a storage area for containerized liquids and scrap, liquids such as lubrication oil, fuels, and solvents may have spilled or leaked, impacting the shallow soil at the site. Soil at the site has also been impacted by the spillage of PCB-contaminated oil from scrap electrical components. The Phase I remedial investigation (RI) report documented that in 1984, approximately 5 gallons of PCB-containing oil were spilled from a leaking electrical console in a small area at the east end of the main storage yard (JEG 1993). PCB-contaminated soil in the spill area (approximately 1,500 square feet) was excavated to a depth of 1 foot below grade. A hazardous waste contractor transported the excavated soil to an offsite disposal facility. No other spills have been documented at the site.





FS Addendum		Final
Project Location Map IRP Site 8		
Date 02-06	MCAS El Toro	Figure 2-1
Project No. 29307	EarthTech A Tyco International Ltd. Company	

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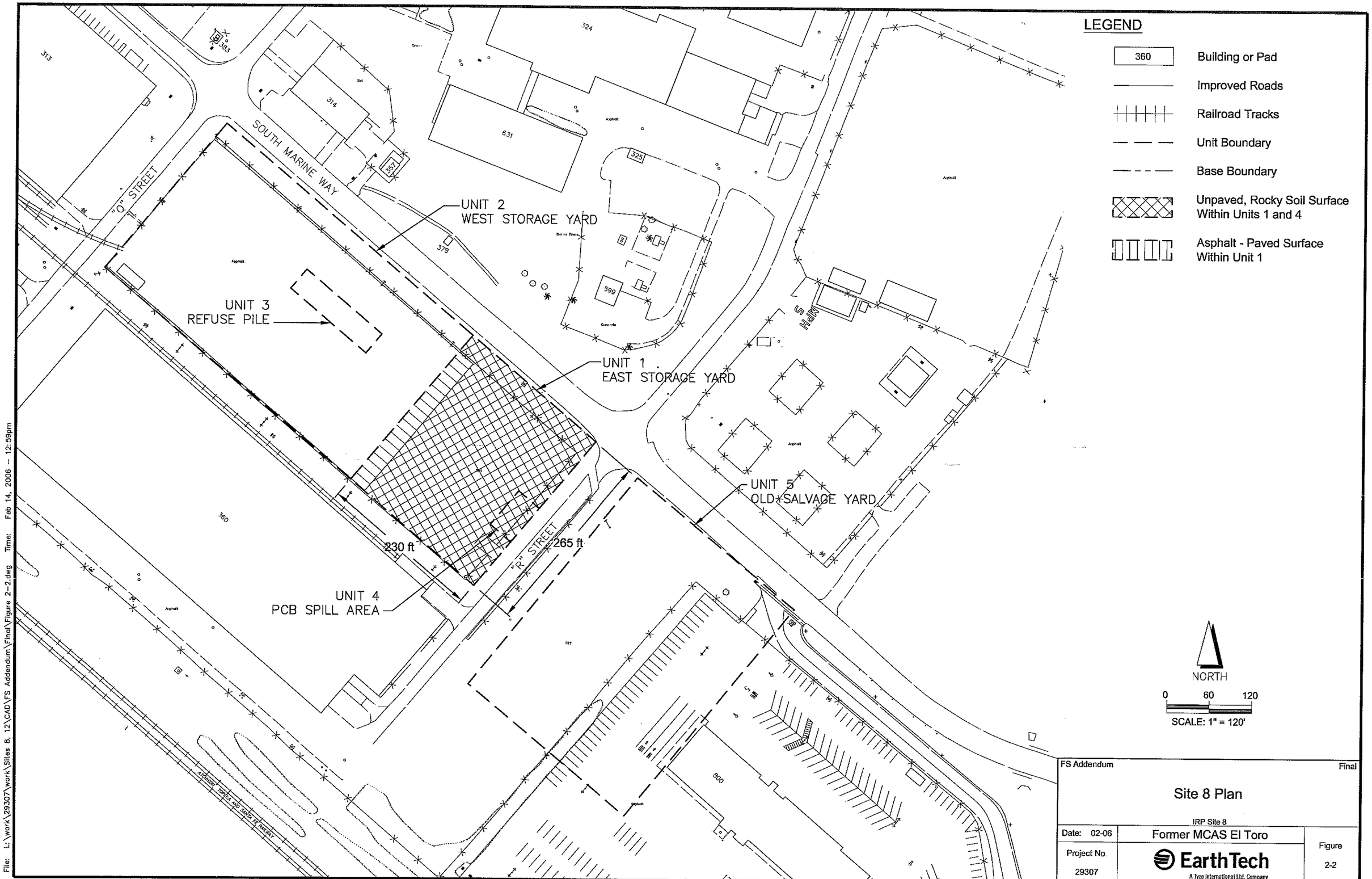

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Site 8 Plan

IRP Site 8

Date: 02-06	Former MCAS El Toro	Figure 2-2
Project No. 29307	EarthTech, A Tyco International Ltd. Company	

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The Phase II RI report (BNI 1997a) documented that a refuse pile (Unit 3) was observed near the center of the main storage yard on aerial photographs dating back to 1952. This refuse pile remained visible in aerial photographs through 1990. The pile was removed and disposed of prior to initiation of the Phase I RI in 1991. In December 1993, the top 2 feet of the soil beneath the refuse pile was excavated and removed from Site 8 by a paving contractor.

2.1.2.1 HISTORY OF NON-RADIOLOGICAL EVALUATION

This section presents the investigation activities and documents prepared to address non-radioactive contamination including volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), pesticides, PCBs, total petroleum hydrocarbons (TPH), total recoverable petroleum hydrocarbons (TRPH), herbicides, and target analyte list (TAL) metals at Site 8. The investigations conducted to identify the nature and extent of radiological contamination at Site 8 are presented in Section 2.1.2.2.

In 1992 and 1993, the remedial action evaluation process was started for Site 8 with a Phase I RI (JEG 1993). Subsequent to the Phase I RI, a Phase II RI was conducted in 1995 and 1996 for Site 8 in conjunction with other operable unit (OU)-3A sites (Sites 11 and 12) (BNI 1997a). The Phase II RI report for OU-3A sites (Sites 8, 11, and 12) provided an interpretation of the nature and extent of non-radioactive contamination at Site 8 based on the review of data obtained from an aerial photograph survey, and soil sampling and analysis conducted as a part of the Phase I and II RIs. The site characterization information obtained from the Phase I and II RIs was used to complete a FS for Site 8 in July 1997 (BNI 1997b). The FS identified and evaluated the alternatives that could be potentially used to remediate non-radioactive COPCs (e.g., PCBs and PAHs) at the site. Based on the results of the FS, a Proposed Plan (in conjunction with Sites 11 and 12) was released for public comment for Site 8, Units 3 and 5 in May 1999 (DON 1999b). The Proposed Plan identified Alternative 3, excavation, with recycling of the excavated soil as cover material at the on-Station Sites 2 and 17 landfills, as the preferred alternative for the portions of the site contaminated with non-radioactive chemicals. Off-Station disposal of contaminated soil was also presented as a disposal option in the Proposed Plan. It was determined that Units 1, 2, and 4 of Site 8 do not require remedial action.

Following issuance of the Proposed Plan, a Draft ROD was prepared for Sites 8 in combination with other OU-3A sites (Site 11 and 12) at MCAS El Toro (DON 1999a). This Draft ROD selected no further action (NFA) for Site 8, Units 1, 2, and 4 and further action for Site 8, Units 3 and 5.

The selected remedy for Site 8, Units 3 and 5—noted as Alternative 3 in the Draft ROD—consisted of excavation of non-radioactively contaminated soil with recycling of excavated soil as cover material at the on-Station Site 2 or 17 landfills. The remedy included confirmation sampling after excavation to ensure that the contaminated soil exceeding the residential risk-based concentrations (RBCs) for the non-radioactive contaminants of concern (COCs) (e.g., PCBs and PAHs) at each area has been removed. The RBCs were calculated based on the risk assessment conducted as a part of the Phase II RI.

As a part of post-ROD activities, the human health risk assessment conducted during the Phase II RI was reviewed in detail. The review showed that several exposure factors and toxicity indices used to derive the risk estimates were not current, based on a comparison with those used by Region IX of the EPA in the development of its preliminary remediation goal (PRG) table (EPA Region IX 2000). It was also determined that the data from additional soil sampling conducted in May 1999 (subsequent to the Phase II RI) at Site 8, Unit 5 (OHM/IT Group 1999) should also be incorporated into the risk assessment and the calculation of the RBCs. Thus, a risk reevaluation was conducted,

utilizing all the available data and the California Environmental Protection Agency (Cal/EPA) and EPA Region IX toxicity information and exposure factors for the year 2000 (Earth Tech 2003).

In general, the results of this updated risk assessment indicated lower risks than the Phase II RI risk assessment values. Based on the updated cancer and noncancer risk values, the report concurred with the NFA recommendation in the Draft ROD for Site 8, Units 1, 2, and 4 (DON 1999a). Additionally, the report recommended NFA for Site 8, Unit 5. For Site 8, Unit 3, the remedy selected in the Draft ROD was retained. The BRAC Cleanup Team (BCT) concurred with all the recommendations.

Subsequent to the preparation of the FS and Draft ROD, Ra-226 contamination was identified at Site 8; therefore radiological investigations were conducted to assess the extent of Ra-226 at Site 8. The history of these investigations is presented in the following sections.

2.1.2.2 *History of Radiological Evaluation*

Subsequent to the preparation of the FS and Draft ROD, a radiological evaluation of Site 8 was conducted as a part of stationwide historical radiological assessment (HRA) for the former MCAS El Toro in 1999 and 2000 (Weston 2000). The purpose of the HRA was to identify potential, likely, or known sources of radioactive material and radioactive contamination based on existing or derived information and to identify sites that need further action as opposed to those posing no threat to human health. As a part of HRA, interviews, records review, site inspections, and limited informal surveys were conducted at MCAS El Toro. Based on the survey results, Site 8 was recommended for further investigation, including radiological surveys, since it potentially handled small quantities of Ra-226 painted parts and gauges. Subsequent to the issuance of the HRA, on-site radiological characterization surveys and sampling were conducted at Site 8 in June – November 2001 and March 2004. These investigations were performed in accordance with the Radiological Survey Plan (Weston 2001) and the Radiological Sampling Amendment (Weston 2003) at all five units of IRP Site 8.

An analysis of data obtained from radiological surveys and soil sampling at Site 8 indicated that the site could be divided into two parts based on the level of Ra-226 contamination. The Ra-226 concentrations at Units 2, 3, and 5 of Site 8 were found to be consistent with the background, whereas locations with higher than background concentrations of Ra-226 were found at Units 1 and 4 of the site. Therefore, a radiological release report for Units 2, 3, and 5 of Site 8 was issued in conjunction with IRP Site 12, and IRP Site 25 (Bee Canyon Wash Outfall) (Weston 2004a). Based on the statistical analyses of the Ra-226 data, and risk and dose assessments, this report concluded that the occurrence and distribution of Ra-226 at Units 2, 3, and 5 of Site 8 are consistent with ambient concentrations. Therefore, a Site Evaluation Accomplished (SEA) recommendation was made for Units 2, 3, and 5 of Site 8. The SEA recommendation denotes that the CERCLA requirement for the site evaluation of radionuclides has been accomplished, and radionuclides will be removed from the list of COPCs and further consideration under CERCLA at these units. However, since locations with higher than background concentrations of Ra-226 were found at Units 1 and 4 of Site 8, these units were selected for further response action under CERCLA.

2.1.3 Physical Characteristics of the Site

The terrain in the immediate vicinity of Site 8 is relatively flat, ranging from 0 to 2 percent in slope. Approximately 90 percent of the total area of Units 1 and 4 consists of gravel and bare soil, and the remaining 10 percent consists of an asphalt-paved surface (see Figure 2-1). Surface drainage from Site 8 flows to the adjacent streets and surrounding areas (JEG 1993).

The mean annual rainfall at Site 8 is about 12.2 inches per year. The evapotranspiration rates are high and net infiltration from precipitation is less than 5 inches per year (BNI 1997b)

The geology of Site 8 consists of Quaternary alluvial and marine sediments (JEG 1993) composed of a matrix of fine-grained overbank deposits and some coarse-grained stream channel deposits. At Site 8, these sediments are overlain locally by varying thickness of imported fill material. A review of borings logs compiled during the RI indicates that shallow soil at Site 8 consists of fine- to coarse-grained sand interbedded with silty sand. The overlying fill material, likely derived from a nearby borrow area, also consists predominantly of fine- to coarse-grained sand. The shallow soil and fill material were characterized as "dry to moist," suggesting low moisture content consistent with the low average annual rainfall reported for former MCAS El Toro. Groundwater is present beneath Site 8 at a depth of approximately 120 feet below ground surface (bgs) (BNI 1997b).

2.2 NATURE AND MECHANISM OF RELEASE

Ra-226 is the radionuclide of potential concern at Units 1 and 4 of Site 8. The exact source and mechanism of release of Ra-226 at Site 8 are not known. However, the HRA and information on historical Station operations indicate that potential sources of Ra-226 include Ra-226 painted parts, gauges, dials and markers. The employee interviews during the HRA indicated small quantities of radium-painted parts and gauges may have been stored at Site 8 (Weston 2000). Additionally, historical operations at the former MCAS El Toro included repair of aircraft equipped with Ra-226 containing components. Radium-containing components including radioluminescent dials, gauges, and markers were commonly used on aircraft in the 1940's, 50's and 60's.

Considering the fact that potential sources of Ra-226 at Units 1 and 4 are from storage of Ra-226 painted parts, gauges, dials, and markers, release of Ra-226 is likely to be restricted to the shallow soil (less than 18 inches bgs approximately).

It should be noted that equipment and consumer products such as electron tubes (historically containing cobalt-57 [Co-57], cobalt-60 [Co-60], thorium [Th-232], krypton [Kr-85], etc.), smoke detectors (americium-241 [Am-241]), exit signs (hydrogen-3 [H-3]), which contain exempt quantities of radioactive materials, may have also existed at Site 8. Contamination, as a possible result of their use, would typically only produce contamination at a small fraction of the release limit (established in terms of average Ra-226 concentration above background reference level, and the associated incremental risk and dose above background, to a residential receptor). Therefore, these radionuclides are not of concern (Weston 2004a).

2.3 EXTENT OF RA-226

On-site radiological characterization surveys and soil sampling were conducted at Units 1 and 4 of Site 8 in June through November 2001 to assess the distribution of Ra-226 in the shallow soil. These investigations were performed in accordance with Radiological Survey Plan (Weston 2001). The details of methodology, procedures, and evaluation of results for radiological investigations conducted at Units 1 and 4 of Site 8 are presented in Appendix A. The following sections present a summary of measurement methods and investigation results.

2.3.1 Radiological Investigation Methods Summary

The radiological scan surveys at Site 8 were conducted utilizing high-density global positioning system (GPS) survey process, using an eight-detector array for the survey, supplemented with backpack GPS single detector surveys in areas where access for the eight-detector system was not feasible. The instruments used for the scan surveys were portable scaler/ratemeters equipped with sodium iodide (NaI) crystal scintillation probes (i.e., 2 inch x 2 inch [unshielded] and/or 3 inch x 3 inch [shielded] detectors for gamma detection).

A total of 89,356 scan survey readings were collected at Units 1 and 4 of Site 8 (see Figure 2-3). Soil samples were collected from 16 locations where elevated readings were observed during the scan survey and sent to a certified laboratory for analysis of Ra-226. If, during sampling, a radiological anomaly was encountered, it was assigned an identification number and a visual description was recorded.

To differentiate between naturally occurring radiation and residual radioactivity in potentially impacted areas, station background radiation levels were measured in reference areas and were used for comparison purposes. The non-impacted reference areas were selected from locations with similar characteristics (chemically, physically, biologically, and geologically) to Site 8. The reference areas were located up gradient or cross gradient from Site 8.

Background radiation levels were measured using the same survey and sampling procedures as Units 1 and 4 of Site 8. The background radiation levels were established using the average radiological scan survey data and average soil sample analytical results obtained from survey and sampling performed in reference areas. The average background radiation level for scan surveys was established by scanning a rocky soil and asphalt area located north of Site 8 near Building 324 (see Figure 2-2). The average background concentration of Ra-226 for soil sampling was established by collecting samples for Ra-226 analysis in various non-impacted reference areas across the entire MCAS El Toro. These average values were used to differentiate statistically between naturally occurring radiation and residual radioactivity in any potentially impacted areas.

The analysis of results for radiological investigations was performed as follows:

- A derived concentration guideline level (DCGL) of 1 pico-Curie per gram (pCi/g) above background was established for Site 8. The risk and dose modeling conducted in support of this FS Addendum demonstrated that a Ra-226 concentration of 1 pCi/g above background satisfies the NRC dose criteria of 25 mrem/y and results in a risk within the acceptable NCP risk range of 10^{-6} to 10^{-4}, for residential (unrestricted release) scenario. Additionally, the cost-benefit analysis shows that this concentration of Ra-226 is as low as reasonably achievable (ALARA) (see Appendix B for details).

  Radiological analyses performed on 15 background reference area soil samples collected throughout the Station yielded a mean background soil concentration for Ra-226 of 1.05 pCi/g. Using a DCGL of 1 pCi/g above the mean background, the total Ra-226 release level for the Station was set at 2.05 pCi/g.

- The scan survey readings (in counts per minute [cpm]) were converted to equivalent soil concentrations of Ra-226 (in pCi/g) using calculated instrument efficiency (cpm per pCi/g) and compared to scan minimum detectable concentrations (MDCs) (1.48 pCi/g for 3-inch x 3-inch NaI detector and 1.45 pCi/g for the 2-inch X 2-inch NaI detector) and the DCGL of 2.05 pCi/g (see Appendix A for details).

- The concentrations of Ra-226 in soil samples were directly compared to the release level of 2.05 pCi/g.

It should be noted that groundwater was not addressed as a medium of potential concern during radiological investigations because:

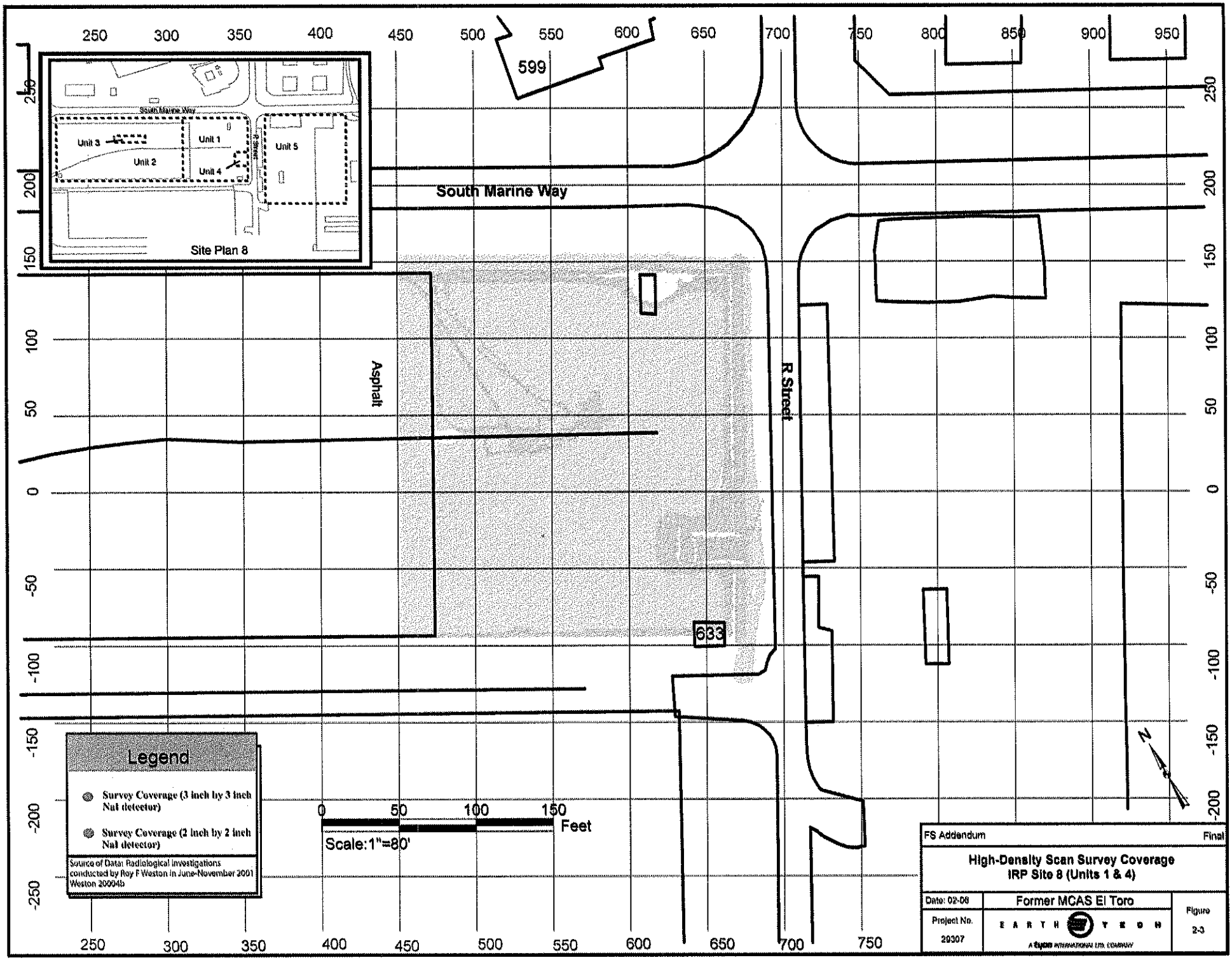
Site Plan 8
South Marine Way
Unit 1
Unit 2
Unit 3
Unit 4
Unit 5
R Street
599
633
Asphalt
South Marine Way
R Street
Legend
Survey Coverage (3 inch by 3 inch NaI detector)
Survey Coverage (2 inch by 2 inch NaI detector)
Source of Data: Radiological investigations conducted by Roy F Weston in June-November 2001 Weston 20004b
0 50 100 150
Feet
Scale: 1"=80'
N
FS Addendum
Final
High-Density Scan Survey Coverage
IRP Site 8 (Units 1 & 4)
Date: 02-08
Former MCAS El Toro
Project No. 29307
EARTH TECH
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Figure 2-3

- The potential source of Ra-226 contamination is radium-containing components used on aircraft in the 1940s, 50s, and 60s, including, radioluminescent dials, gauges, and markers. The contamination resulting from these sources is likely to be restricted to the shallow surface soil.
- Radium is readily adsorbed by the soil and is usually not a mobile constituent in the environment. This along with site-specific considerations, including depth to groundwater of 120 feet bgs, low mean annual rainfall (12.2 inches per year), and low average infiltration (less than 5 inches per year), suggest that there is very low potential for leaching of Ra-226 to the groundwater.
- The stationwide evaluation of radionuclides in groundwater concluded that radionuclides at the former MCAS El Toro are naturally occurring (Earth Tech 2000, Earth Tech 2001)

2.3.2 Summary of Investigation Results

Of the total of 89,356 high density scan survey readings, 394 data points were observed to exceed the approximate scan survey DCGL (2.05 pCi/g equivalent count rate in cpm) for the shielded 3-inch x 3-inch NaI detector and the unshielded 2-inch x 2-inch NaI detector). The average radiation levels were 7,707 cpm for the shielded 3 inch x 3 inch detector, and 10,998 cpm for the unshielded 2 inch x 2 inch detector. The highest individual scan survey readings were 87,073 cpm for the 3 inch x 3 inch detector, and 51,295 for the 2 inch x 2 inch detector. Figure 2-4 provides a colored graphical depiction of the various radiation levels detected using the high-density survey process. Table 2-1 provides a summary of the survey data results.

Table 2-1: Scan Survey Data Summary

Instrument (Scintillation Detector)	Total Survey Points	Maximum Reading (cpm)	Mean Reading (cpm)	Standard Deviation (cpm)	No. of Readings above DCGL
Shielded 3" x 3" NaI Detector	83,174	87,073	7,707	1,472	137
Unshielded 2" x 2" NaI Detector	6,182	51,295	10,998	3,739	257

Of the 16 soil samples collected, 15 samples contained Ra-226 concentrations greater than 1 pCi/g above background. The concentrations of Ra-226 in these samples ranged from 7.5 to 329 pCi/g, and averaged 95.98 pCi/g (Table 2-2 and Figure 2-5).

During sampling of Units 1 and 4, eight radiological anomalies were removed. The removed items comprised three sheet-metal label tags, one small screw, two pieces of asphalt, and three scoops of soil/rock (Table 2-3 and Figure 2-5).

The analysis of the above data indicates that Ra-226 contaminated soil above DCGL is not evenly distributed at Units 1 and 4 of Site 8. There appear to be discrete patches of elevated Ra-226 distributed throughout Units 1 and 4 except in the northeastern and southwestern portions indicating the discrete nature of the sources of release (i.e., Ra-226 painted parts, gauges, dials, and markers).

2.4 RA-226 FATE AND TRANSPORT

Ra-226 is not stable and continuously decays to release radiation and form decay products. Radiation is released during the decay process in the form of alpha and beta particles, and gamma radiation. Alpha particles can travel only short distances and cannot penetrate human skin. Beta particles are generally absorbed in the skin and do not pass through the entire body. Gamma radiation, however, can penetrate the body. Isotopes of radium, including Ra-226 decay to form radioactive isotopes of radon gas. Radon is known to accumulate in homes and buildings (EPA 2002).

Radium is readily adsorbed by the soil and is usually not a mobile constituent in the environment (ATSDR 1990). This behavior coupled with low mean annual rainfall (12 2 inches per year) and low average infiltration (less than 5 inches per year) at Site 8 (BNI 1997a), suggests that there is a limited potential for mobilization of Ra-226 by surface water runoff and soil infiltration. However, risk exists for mobilization of Ra-226 in the soil at Site 8 by wind erosion and fugitive dust, since Units 1 and 4 of Site 8 consist of gravel and bare soil (Figure 2-6).

Table 2-2: Soil Sampling Results

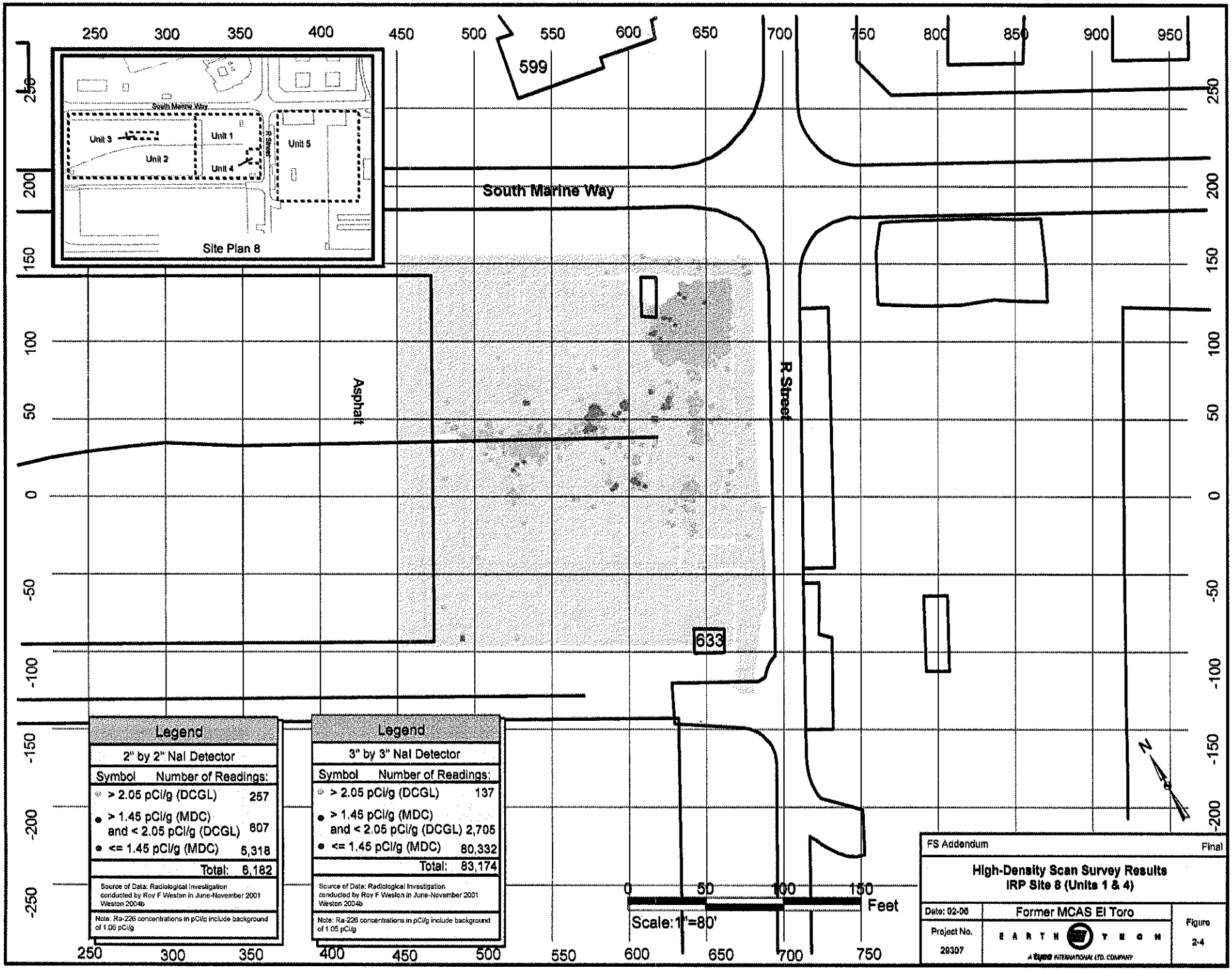
Sample No.[a]	Reading Before[b] (cpm)	Reading After[c] (cpm)	On Contact[d] (cpm)	Gamma Spectrometry Results	
				Ra-226 (pCi/g)	Estimated Error (pCi/g)
2	28,631	23,002	8,951	8.90	1.6
3	51,632	36,995	15,183	16.10	2.7
4	132,007	30,317	24,165	63.00	11
5	65,726	43,631	15,990	45.40	7.7
6	78,007	49,196	29,693	329.00	54
7	91,152	30,777	21,441	76.00	13
8	16,088	16,109	15,639	7.50	1.4
9	39,999	34,980	16,667	49.20	8.2
10	131,637	61,373	35,742	256.00	42
11	97,300	35,936	13,233	19.80	3.4
12	107,152	45,628	37,845	307.00	51
13	32,942	23,590	13,437	15.70	2.7
14	20,214	16,762	14,403	19.10	3.2
15	10,499	10,416	12,127	0.95	0.29
16	406,605	235,204	33,776	239.00	40
17	57,700	36,846	21,985	83.00	14
Average	**85,456**	**45,673**	**20,642**	**95.98**	

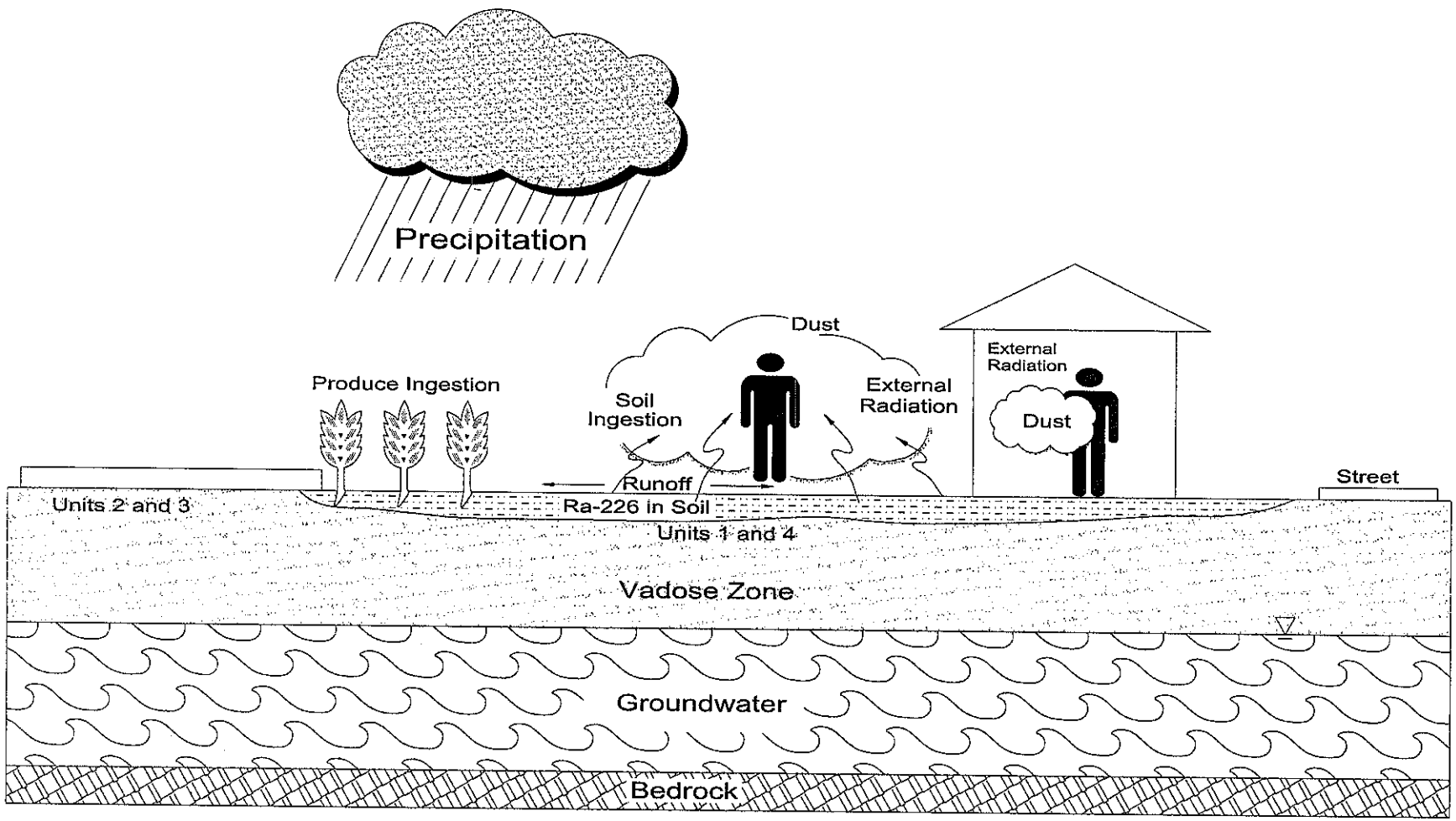
Notes:
[a] See Figure 2-5 for sampling locations.
[b] Highest one-minute gamma reading observed on ground surface prior to collecting sample using 2 inch x 2 inch NaI detector.
[c] Highest one-minute gamma reading observed on ground surface after sample has been collected using 2x2 NaI detector.
[d] On-contact one-minute reading taken on outside of sample container using 2x2 NaI detector.

Table 2-3: Anomalies Description

Anomaly[a] No.	Description	Anomaly On-Contact Reading[b] (cpm)
3	Chunk of asphalt	66,064
4	Small metal tag	109,199
6	Removed half a bag of rocks and dug to 6" depth; could not find any discrete sources	35,448
7	2 anomalies; one small screw and one scoop of dirt/rocks	140,736
11	Metal label plate 1/2" x 2"	188,972
12	One scoop of dirt with rocks	141,483
16	Chunk of asphalt; dug to 6"; could not find any discrete sources	83,121
17	Metal label plate 1/2" x 2"	62,249

Notes:
[a] See Figure 2-5 for anomaly locations
[b] On-contact one-minute reading taken on outside of anomaly container using 2x2 NaI detector.


South Marine Way
Unit 3
Unit 1
Unit 2
Unit 4
Unit 5
Site Plan 8
599
633
Asphalt
R Street
Legend
2" by 2" NaI Detector
Symbol Number of Readings:
> 2.05 pCi/g (DCGL) 257
> 1.45 pCi/g (MDC) and < 2.05 pCi/g (DCGL) 607
<= 1.45 pCi/g (MDC) 5,318
Total: 6,182
Source of Data: Radiological Investigation conducted by Roy F Weston in June-November 2001 Weston 2004b
Note: Ra-226 concentrations in pCi/g include background of 1.05 pCi/g
Legend
3" by 3" NaI Detector
Symbol Number of Readings:
> 2.05 pCi/g (DCGL) 137
> 1.45 pCi/g (MDC) and < 2.05 pCi/g (DCGL) 2,705
<= 1.45 pCi/g (MDC) 80,332
Total: 83,174
Source of Data: Radiological Investigation conducted by Roy F Weston in June-November 2001 Weston 2004b
Note: Ra-226 concentrations in pCi/g include background of 1.05 pCi/g
0 50 100 150 Feet
Scale: 1"=80'
FS Addendum
Final
High-Density Scan Survey Results
IRP Site 8 (Units 1 & 4)
Date: 02-06
Former MCAS El Toro
Project No. 28307
EARTH TECH
A Tetra Tech International Ltd. Company
Figure 2-4



FS Addendum — Final

Site 8 - Units 1 and 4 Conceptual Site Model

IRP Site 8

Date: 02-06	Former MCAS El Toro	Figure 2-6
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action that subsurface contamination exists at a level between 5pCi/g to 15 pCi/g averaged over areas of 100 square meters (the averaging areas provided for in Part 192 rules), this indicates that conditions at the site are probably not sufficiently similar to a UMTRCA site to consider the subsurface standard at 40 C.F.R. 192 relevant and appropriate. If contamination at the site is unlike that of uranium mill tailings sites, in that significant subsurface contamination exists at a level between 5 pCi/g and 30 pCi/g, the use of 15 pCi/g standard is not generally appropriate. Instead, 5 pCi/g is recommended since that was the actual health-based standard expected to be achieved by 40 C.F.R. 192. Where these standards are identified as ARARs for Ra-226 and Ra-228, they should also be applied to parents of these, thorium-230, and thorium-228.

UMTRCA standards for the control of residual radiological materials from inactive uranium processing sites are found at 40 C.F.R §192.02(b), which provides criteria for releases of radon-222 from residual radiological material to the atmosphere as follows:

"Provide reasonable assurance that releases of radon-222 from residual radioactive material to the atmosphere will not:

1. Exceed an average release rate of 20 picocuries per square meter per second. This average shall apply over the entire surface of the disposal site and over at least a one-year period. Radon will come from both residual radioactive materials and from materials covering them. Radon emissions from the covering materials should be estimated as part of developing a remedial action plan for each site. The standard, however, applies only to emissions from residual radioactive materials to the atmosphere. or,
2. Increase the annual average concentration of radon-222 in air at or above any location outside the disposal site by more than one-half picocurie per liter."

It is highly unlikely that releases of radon-222 from anomalies at Site 8 would exceed the threshold criteria in 40 C.F.R §192.02(b). Therefore, this requirement is not a potential ARAR.

Requirements for cleanup of radiological contaminants are found in UMTRCA standards for cleanup of land and buildings contaminated with residual radiological materials from inactive uranium processing sites. Dose limits for Ra-226 in soil are found at 40 C.F.R §192.12(a), §192.32(b)(2) and §192.41 which states that as a result of residual radiological materials from any designated processing site:

(a) The concentration of Ra-226 in land averaged over any area of 100 square meters shall not exceed the background level by more than,

(1) 5 pCi/g, averaged over the first 15 cm of soil below the surface, and

(2) 15 pCi/g, averaged over 15 cm thick layers of soil more than 15 cm below the surface.

The substantive provisions of 40 C.F.R §192.12(a), §192.32(b)(2), and §192.41 have been determined to be potentially relevant and appropriate for Site 8, Units 1 and 4 since the contaminant (Ra-226) matches and subsurface contamination is expected at levels between 5 to 30 pCi/g in the subsurface. The proposed remedial action will meet these standards.

The requirements at 40 C.F.R § 192.12(b)(1) and § 192.41(b) state that in any occupied or habitable building the objective of remedial action shall be, and reasonable effort shall be made to achieve, an annual average (or equivalent) radon decay product concentration (including background) not to exceed 0.02 Working Level (WL). In any case, the radon decay product concentration (including background) shall not exceed 0.03 WL. Provisions applicable to radon-222 shall also apply to radon-

220. The provisions of 40 C.F.R. § 192.12(b)(1) and § 192.41(b) are potentially relevant and appropriate if habitable buildings are constructed at Units 1 and 4 of Site 8 as a part of site reuse.

For concentration limits for cleanup of gamma radiation in buildings at inactive uranium processing sites designated for remedial action, 40 C.F.R. § 192.12(b)(2) requires that in any occupied or habitable building, the level of gamma radiation shall not exceed the background level by more than 20 microroentgens per hour. The provisions of 40 C.F.R. § 192.12(b)(2) are potentially relevant and appropriate if habitable buildings are constructed at Units 1 and 4 of Site 8 as a part of site reuse.

3.2.4.2 *Potential Action-Specific ARARs Affecting Remedial Action Objectives*

South Coast Air Quality Management District Rules

Certain South Coast Air Quality Management District (SCAQMD) rules were determined to be potential ARARs for air emissions. Fugitive dust emissions are expected from the excavation and earth-moving activities that are a part of remedial action alternatives. The substantive provisions of SCAQMD rules 401, 403, 404, and 405 are potentially applicable for these fugitive emissions.

California Department of Fish and Game Requirements

California Fish and Game Code §§ 3005; 3503; 3503.5; 3800; and 4150, and Cal. Code Regs. tit. 14 § 472 were identified as potential ARARs for protection of biological resources during remedial action implementation at Site 8.

3.2.5 Remedial Action Objectives

Based on the medium of concern, COPCs, potential exposure pathways, and potential ARARs, the following RAOs were developed for remediation of Ra-226 at Units 1 and 4 of Site 8:

- Reduce potential exposure to incremental concentrations (above naturally occurring background levels) of Ra-226 such that residual carcinogenic risk (above background) is in the NCP defined risk management range (10^{-6} to 10^{-4}).
- Reduce potential exposure to incremental concentrations (above naturally occurring background levels) of Ra-226 to achieve compliance with NRC standards for protection against radiation, specified in 10 C.F.R. Sections 20.1402 and 20.1403, such that the total effective dose equivalent (TEDE) (above background) does not exceed 25 mrem/y and that the residual radioactivity (due to Ra-226) has been reduced to levels that are ALARA.

Risk and dose modeling, and ALARA analysis were performed to develop a target cleanup goal and derived concentration guideline level (DCGL) for Ra-226 that achieves the above RAOs (see Appendix B). These evaluations concluded that a target cleanup goal and DCGL for Ra-226 of 1 pCi/g above background results in a risk within the acceptable NCP risk range of 10^{-6} to 10^{-4}, a dose of less than 25 mrem/y, and is ALARA.

3.3 General Response Actions

GRAs describe those actions that will satisfy RAOs. Unlike nonradioactive hazardous substances, which are alterable by physical, chemical, or biological processes that can reduce or destroy the hazard itself, radioactive substances generally cannot be similarly altered or destroyed. Since destruction of radioactivity is not an option, response actions at radioactively contaminated sites use the concepts of "Time, Distance, and Shielding." Time allows the natural decay or the radionuclide to take place, resulting in reduction in risk to human health and the environment. Distance and shielding from the radioactive material rapidly reduce the risk from radiation by reduction of the

intensity of the imparted energy (EPA 1996). The following five GRAs have been identified for Units 1 and 4 of Site 8 based on the NCP and the concepts of "Time, Distance, and Shielding":

- *No Action*: Under this GRA, no further response action will be conducted at the site.
- *Institutional Controls (ICs)*: The ICs include non-engineered instruments such as administrative and/or legal controls that minimize the potential for human exposure to contaminated material by limiting land or resource use. The ICs will be complemented with a perimeter fence to restrict access to the site.
- *Containment*: This GRA includes construction of a physical barrier to reduce contaminant migration, and exposure routes including radiation exposure due to radioactive decay of radionuclide.
- *Immobilization/Containment*: This GRA includes limiting mobility or solubility of the contaminants by physical or chemical measures and constructing a physical barrier primarily to reduce exposure to radiation due to radioactive decay
- *Removal/Volume Reduction/Disposal*. This GRA includes excavation of Ra-226 contaminated soil above the site-specific release criteria, screening to segregate soil exceeding the site-specific release level, and disposal at an appropriate waste disposal facility.

3.4 TARGET REMEDIATION ZONE

The remedial action for Ra-226 will be conducted at Units 1 and 4 of Site 8. Units 1 and 4 constitute an area approximately 265 feet by 230 feet (60,950 square feet). Radiological investigations conducted at Site 8 indicate that discrete patches of elevated Ra-226 concentrations (posing unacceptable risk to human health) are distributed throughout Units 1 and 4 except in the northwestern and southeastern portions. The remedial action will be designed primarily to address surface soil in these areas such that exposure to Ra-226 concentrations posing unacceptable risk to human health is minimized.

The area of contaminated soils with Ra-226 concentrations exceeding the established DCGL (1 pCi/g above background) and posing unacceptable risk to human health is conservatively estimated to be 22,500 square feet (see radiological investigation results presented in Figures 2-4 and 2-5). Assuming the maximum depth of Ra-226 contamination in this area to be 18 inches, the maximum estimated volume of Ra-226 contaminated soil is expected to be approximately 1,250 bank cubic yards (bcy).

3.5 IDENTIFICATION AND SCREENING OF TECHNOLOGY TYPES AND PROCESS OPTIONS

The identification and screening of technology types and process options available for remediation of Ra-226 at Units 1 and 4 of Site 8 was carried out as follows:

- In the first step, potentially available technology types were identified corresponding to each GRA identified for Ra-226 contaminated soil at Units 1 and 4 of Site 8. This was done using the EPA *Technology Screening Guide for Radioactively Contaminated Sites* (EPA 1996). In accordance with the EPA *Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA* (EPA 1988), the technology types included general categories of remediation technologies such as administrative controls, capping, on-site land encapsulation, vertical barriers, cryogenic barriers, solidification/stabilization, vitrification, excavation, dry and wet soil separation, chemical separation, and disposal.

- In the second step, a preliminary screening of the technology types was conducted based on the technical implementability at Site 8 This screening suggested that all the identified technology types are potentially technically implementable. Therefore, technology process options were identified for each remediation technology. For example, the capping technology included three process options, clay cap, synthetic membrane cap, and asphalt/concrete cap.
- In the third step, the technically implementable process options were evaluated based on effectiveness, implementability, and cost, to select a representative process for each technology type (Table 3-1). The effectiveness evaluation concentrated on the ability of the process option to reduce volume, radiotoxicity, and mobility of Ra-226, and attain the RAOs; potential impacts to human health and the environmental during implementation of the process option; and whether the process is reliable and proven for remediation of radionuclides.

  The implementability evaluation focused on technical as well as institutional aspects of implementability, such as the ability to obtain necessary permits and approvals, availability of equipment and skilled workers, extensiveness of knowledge required to implement the process option, and the need for treatment or disposal of process waste.

  The cost evaluation included semi-quantitative analysis based on engineering judgment and the unit costs given in the EPA *Technology Screening Guide for Radioactively Contaminated Sites* (EPA 1996). Based on the unit costs, each process option was evaluated as to whether costs are high, low, or medium relative to other process options in the same technology type.

Table 3-1: Identification and Screening of Technology Types and Process Options

General Response Action	Remedial Technology Type	Remedial Technology Process Option	Technology Process Option Description	Effectiveness[a]	Implementability[b]	Cost[c]	Screening/Evaluation Comments
No-Action	None	None Available	No Action	Does not reduce risks associated with exposure to Ra-226 contaminated soil	Easily implementable since no action needs to be taken.	There are no costs asscociated with technology	**Selected** as a stand-alone alternative in compliance with the NCP.
Land-use Controls and Access Restrictions	Institutional Controls	Institutional Controls	Administrative and/or legal controls that restrict access to the site and prevent land uses that result in unacceptable exposure to human health such a residential land-use.	Does not reduce the volume, radiotoxicity, and mobility of the Ra-226. However, prevents exposure to Ra-226 concentrations that present unacceptable risks to human health. Usually reliable if used in conjunctions with other GRAs including containment and partial removal of contaminated soil. No adverse impacts occur during the implementation phase, since no construction activities are associated with this process option.	Relatively easy to implement	Low	**Selected** for alternative development
	Physical Barrier/Warning Signs	Fencing/Warning Signs	Perimeter fence and warning signs to restrict access to the site.	Does not reduce volume, radiotoxicity, and mobility of the Ra-226. May reduce exposure due to direct contact with contaminated soil. Only effective if used in conjunction with land use restrictions.	Easy to install	Very Low	**Selected** for alternative development.
Containment	Capping	Clay Cap	Covering the contaminated soil with natural low-permeability soils such as clay to minimize exposure and migration of Ra-226. Layers of synthetic membrane liners such as geomembranes may be installed during cap construction to minimize infiltration and provide shielding against radiation.	Does not reduce the volume or radiotoxicity of the contaminated soil. Effective in reducing mobility of Ra-226 and provides shielding against radiation effects. Fairly reliable and well-demonstrated technology if properly maintained. Site workers may get exposed to contaminated soil, fugitive dust and radon gas emissions during construction.	Mature, well-known technology that is relatively easy to implement. Materials and equipment usually readily available. Moderate level of site-knowledge is required for implementation.	Low	**Not Selected** for alternative development.
		Asphalt/Concrete Cap	Containing the contaminated soil by providing crushed aggregate base and asphalt/concrete pavement. This will prevent contaminant migration and provide shielding against radiation.	Does not reduce the volume or radiotoxicity of the contaminated soil. Effective in reducing mobility of Ra-226 and provides shielding against radiation effects. Asphalt/Concrete cap is expected to be more reliable and durable, and need less repair in the long term compared to the clay cap. Site workers may get exposed to contaminated soil, fugitive dust, and gas emissions during construction.	Mature, well-known technology that is relatively easy to implement. Implementation is expected to be easier than clay cap since asphalt/concrete cap is more compatible with existing conditions at the site and the surrounding areas. Materials and equipment usually readily available. Moderate level of site-knowledge is required for implementation.	Low	**Selected** for alternative development.
	On-site Land Encapsulation	On-site Land Encapsulation Unit	Excavating the contaminated area, installing a liner or other impermeable material in the excavated area, and backfilling the lined excavated area with contaminated soil. An appropriate cap is installed over the backfilled area to minimize exposure.	Does not reduce the volume or radiotoxicity of the contaminated soil. Effective in reducing both lateral and vertical migration of Ra-226. Provides shielding against radiation emissions due to radioactively decay of Ra-226. Reliable technology for containment if designed properly. Site workers may get exposed to contaminated soil, fugitive dust ,and gas emissions during construction.	Difficult to obtain regulatory approval for construction of a new land encapsulation facility. Subjected to stringent design guidelines developed by the NRC and EPA.	Medium	**Not Selected** for alternative development
	Vertical Barriers	Slurry Walls	Containing the contaminated media by excavating vertical trenches around the contaminated mass and filling them up with slurry (mix of bentonite and water or cement, bentonite, and water) to reduce contaminant migration due to groundwater movement.	Do not reduce the volume or radiotoxicity of the contaminated soil Vertical barriers may be used to divert flow of uncontaminated groundwater away from the contaminated portion of the vadose zone. Since most of the elevated Ra-226 concentrations at Units 1 and 4 are present in the shallow surface soil and the depth to groundwater is 120 feet, vertical barriers are not required for preventing migration of Ra-226 to groundwater. Without capping, this technology will not reduce potential risk to human health from radiation due to radloactively decay of Ra-226. Site workers may get exposed to contaminated soil, fugitive dust and gas emissions during construction.	High-level of site-specific characterization and experienced personnel required for implementation. Equipment and materials are readily available.	High	**Not Selected** for alternative development.

Table 3-1: Identification and Screening of Technology Types and Process Options

General Response Action	Remedial Technology Type	Remedial Technology Process Option	Technology Process Option Description	Effectiveness[a]	Implementability[b]	Cost[c]	Screening/Evaluation Comments
Containment (contd.)	Vertical Barriers (contd.)	Grout Curtains	Narrow, vertical, grout walls installed in the ground by pressure injecting grout directly into the soil at closely spaced intervals around the contaminated mass to reduce contaminant migration due to groundwater movement	Do not reduce the volume or radiotoxicity of the contaminated soil. Vertical barriers may be used to divert flow of uncontaminated groundwater away from the contaminated portion of the vadose zone. Since most of the elevated Ra-226 concentrations at Units 1 and 4 are present in the shallow surface soil and the depth to groundwater is 120 feet, vertical barriers are not required for preventing migration of Ra-226. Without capping, this technology will not reduce potential risk to human health from radiations due to radioactively decay of Ra-226. Site workers may get exposed to contaminated soil, fugitive dust and gas emissions during construction	High-level of site-specific characterization and experienced personnel required for implementation. Equipment and materials are readily available	High	**Not Selected** for alternative development.
Immobilization /Containment	Cryogenic Barrier	Cryogenic Barrier	Freezing the contaminated soil mass to create an ice barrier around a contaminated zone. Reduces the mobility of the radionuclide contaminants by confining the materials.	Does not reduce the volume or radiotoxicity of the contaminated soil. Effective in reducing both lateral and vertical migration of Ra-226. Since the radioactive material remains in place, there is a potential risk to human health due to radioactive emissions particularly from contaminants located near the ground surface. Cryogenic barriers have not yet been demonstrated at an actual radionuclide-contaminated site (EPA 1996). Site workers may get exposed to radiation during installation of refrigerant piping.	High-level of site-specific characterization and experienced personnel required for implementation. Equipment is generally readily available. A long-term power source is required.	Medium	**Not Selected** for alternative development
	Solidification /Stabilization	In-situ or Ex-situ Chemical Solidification/Stabilization	Limiting the solubility and mobility of the contaminants by addition of chemical reagent (thermoplastic or thermosetting polymers) in-situ or ex-situ to the contaminated soil. Some form of capping may be required to shield or minimize radiation effects.	Does not reduce the volume or radiotoxicity of the contaminated soil. Without capping, this technology does not reduce potential risk to human health from radioactive emissions. Since Ra-226 is not a mobile constituent in environment, this process provides little benefit over simple capping. The reliability of most chemical stabilizing agents has not been fully demonstrated. Site workers may get exposed to contaminated soil, fugitive dust and gas emissions especially during ex-situ implementation.	High-level of site-specific characterization and extensive laboratory and treatability testing is required before implementation of this technology. Equipment and materials are generally readily available.	Low	**Not Selected** for alternative development.
		In-situ or Ex-situ Cement Solidification/Stabilization	Limiting the solubility and mobility of the contaminants by addition of cement or a cement-based mixture in-situ or ex-situ to the contaminated soil. Some form of capping may be required to shield or minimize radiation effects.	Does not reduce the volume or radiotoxicity of the contaminated soil. Without capping, this technology does not reduce potential risk to human health from radioactive emissions. Since Ra-226 is not a mobile constituent in environment, this process provides little benefit over simple capping. The reliability of this process in withstanding long-term impacts of environmental conditions has not been fully demonstrated. Site workers may get exposed to contaminated soil, fugitive dust and gas emissions especially during ex-situ implementation.	High-level of site-specific characterization and extensive laboratory and treatability testing is required before implementation of this technology. Equipment and materials are generally readily available.	Low	**Not Selected** for alternative development.
	Vitrification	In-situ Nitrification	Melting the soil or other media at extremely high temperatures (1,600 to 2000 °C) using electric current such that radionuclides and other pollutants are immobilized within the vitrified glass (a chemically stable, leach resistant material similar to obsidian or basalt rock). Additional protective measures such as a cap may be required to shield or minimize radiation effects.	Reduces the volume and mobility of the contaminated soil but does not reduce radiotoxicity of the contaminated soil. Without capping, this technology does not reduce potential risk to human health from radioactive emissions. Since Ra-226 is not a mobile constituent in environment, this process provides little benefit over simple capping. In-situ vitrification is proven, commercially available technology. It is relatively safe for workers and public since no material is extracted and thus the exposure is minimal. However an off-gas treatment system may be necessary to prevent vitrification emissions from escaping into the air.	High-level of site-specific characterization required. The process is highly complex and implementation is difficult. On-site electrical distribution system, off-gas treatment system, and process control system required for implementation.	Medium	**Not Selected** for alternative development.

Table 3-1: Identification and Screening of Technology Types and Process Options

General Response Action	Remedial Technology Type	Remedial Technology Process Option	Technology Process Option Description	Effectiveness[a]	Implementability[b]	Cost[c]	Screening/Evaluation Comments
Immobilization /Containment (contd.)	Vitrification (contd)	Ex-situ Vitrification	Immobilizing Ra-226 ex-situ within a vitrified glass by melting the soil at extremely high temperatures using plasma torch technology or electric current. Additional protective measures such as a cap may be required to shield or minimize radiation effects.	Reduces the volume and mobility of the contaminated soil but does not reduce radiotoxicity of the contaminated soil. The nonleaching glassy solid product obtained from vitrification requires special storage since vitrification does not reduce wastes radioactivity. Since Ra-226 is not a mobile constituent in environment, this process provides little benefit over simple capping. Ex-situ vitrification technologies are still in developmental stage and have not been fully demonstrated. Excavation and/or handling of contaminated soil may increase the risk to workers and surrounding population. An off-gas treatment system may be necessary to destroy vitrification emissions.	High degree of specialized skill and training required for implementation. High-level of site-specific characterization required.	High	**Not Selected** for alternative development.
Removal / Volume Reduction /Disposal	Excavation	Excavation	Excavation of soil with Ra-226 concentrations posing unacceptable risk to human health using appropriate equipment.	Effective in reducing volume of contaminated soil on-site. When used with other technologies such as physical and chemical separation technologies and off-site disposal into licensed disposal facilities, this technology can reduce toxicity to on-site receptors and mobility of Ra-226. Fugitive dust and gas generated during excavation and processing may pose health and safety risks to workers and the local community.	Easy to implement. Equipment and materials are readily available.	Low	**Selected** for alternative development
	Dry Soil Separation	Segmented Gate System (SGS)	Characterization and sorting the contaminated soil using SGS technology that automatically separates the portion of soil exceeding the cleanup standard from the soil below the cleanup standard.	Separates excavated radioactive soil particles from clean soil particles, thus reducing the volume of the soil requiring further treatment or disposal. Reduction in toxicity and mobility of radionuclides is not addressed by this technology. Effectiveness and reliability of the SGS system for separating and segregating Ra-226 contaminated soil above and below the cleanup criteria for IRP Site 8 are not fully demonstrated. Fugitive dust and gas generated during excavation and processing may pose health and safety risks to workers and the local community.	High degree of specialization and equipment calibration needed for desired segregation	Medium	**Not Selected** for alternative development
		Manual Screening	Manual screening of excavated soil to separate the soil exceeding the cleanup standard from the soil below the cleanup standard. This may be accomplished by soil sampling and analyses in the field.	Separates excavated radioactive soil particles from clean soil particles, thus reducing the volume of the soil requiring further treatment or disposal. Effectiveness and reliability of manual screening for separating and segregating Ra-226 contaminated soil above and below the cleanup criteria for IRP Site 8 are not fully demonstrated. Reduction in toxicity and mobility of radionuclides is not addressed by this technology. Fugitive dust and gas generated during excavation and processing may pose health and safety risks to workers and the local community.	High degree of specialization and equipment calibration needed for desired segregation.	Low	**Not Selected** for alternative development.
	Wet Soil Separation	Soil Washing	Excavated soil is mixed with water to produce slurry feed. This slurry feed may be subjected to physical separation processes to remove more contaminated fine soil particles from less contaminated granular particles. Radionuclides may be extracted chemically from the slurry feed.	Effectively separates contaminated soil fines from clean, larger soil particles, thereby reducing the volume of the soil requiring further treatment or disposal. The process wash water may contain elevated levels of radionuclides and may require treatment and/or disposal. Reduction in toxicity and mobility of radionuclides is not addressed by this technology. The process is generally reliable but needs further development to ensure effectiveness with radionuclide contamination in soil. Fugitive dust and gas generated during excavation and processing may pose health and safety risks to workers and the local community.	High-level of site-specific characterization including detailed grain-size information is required. Process wash water will require treatment or disposal.	High	**Not Selected** for alternative development.
		Flotation	Separation of radionuclide-contaminated soil fractions (usually fine grained particles) from the clean soil fractions (large granular soil particles) by addition of a flotation agent to make the contaminated soil particles float.	Effectively separates contaminated soil fines from clean, larger soil particles, thereby reducing the volume of the soil requiring further treatment or disposal. The foam generated during this process contains elevated levels of contaminants and requires treatment and disposal. Reduction in toxicity and mobility of radionuclides is not addressed by this technology. The process has not been fully demonstrated for reducing the volume of radionuclide-contaminated soil. Fugitive dust and gas generated during excavation and processing may pose health and safety risks to workers and the local community	This technology has only been tested on bench scale. Suitable floating agents may not be available. High-level of site-specific characterization including particle size and shape distribution; association of radionuclides with particle size; clay, humus, sand and silt content; and specific gravity, chemical composition, and mineralogical composition is required for implementation. The foam generated during the process will require treatment or disposal.	Medium	**Not Selected** for alternative development

Table 3-1: Identification and Screening of Technology Types and Process Options

General Response Action	Remedial Technology Type	Remedial Technology Process Option	Technology Process Option Description	Effectiveness[a]	Implementability[b]	Cost[c]	Screening/Evaluation Comments
Removal / Volume Reduction /Disposal (contd.)	Chemical Separation	Solvent/Chemical Extraction	Ex-situ chemical separation technology that involves excavating and mixing the soil with an appropriate solvent. When the hazardous contaminants have been sufficiently extracted, the solvent in separated from the soil and distilled in an evaporator or column. Distilled vapor consisting of relatively pure solvent is recycled, and the liquid residue with concentrated contaminants undergoes further treatment or disposal.	Effectively concentrates the contaminants into a smaller volume allowing for more efficient final disposal. The process liquid residue containing concentrated waste must be treated further, stored or disposed of. Reduction in toxicity and mobility of radionuclides is not addressed by this technology. The process is still under development to treat soils contaminated with radionuclides. Fugitive dust and gas generated during excavation and processing may pose health and safety risks to workers and the local community.	High-level of site-specific characterization, field trials and treatability testing required. The technology is under development for application for radionuclides. The process liquid generated will require further treatment or disposal.	High	**Not Selected** for alternative development
	Disposal	Disposal	Disposal of excavated radioactively contaminated soil into a facility licensed to receive low-level radioactive waste.	Effective in reducing volume of contaminated soil on-site by transferring the contaminated soil to off-site disposal facility. Mobility of the contaminants is also reduced if the selected facility is sufficiently encapsulated. However, there is no change in radiotoxicity of the contaminants. Excavation and transportation of the waste may pose health and safety risks to workers and local community.	Easy to implement	High	**Selected** for alternative development

Notes:

[a] Evaluation factors included ability of the process option to reduce volume, radiotoxicity, and mobility of Ra-226, and attain the RAOs; potential impacts to human health and the environmental during implementation of the process option; and whether the process is reliable and proven for remediation of radionuclides.

[b] Evaluation factors included ability to obtain regulatory approval; availability of equipment and skilled workers; extensiveness of knowledge required to implement the process option; and need for treatment or disposal of process waste.

[c] Each process option was rated (high, low or medium) based on cost relative to other process options in the same technology type based on the engineering judgment and unit costs presented in EPA 1996

4. DEVELOPMENT OF ALTERNATIVES

The remedial action alternatives for Units 1 and 4 were developed by combining different technologies and process options corresponding to different GRAs (Figure 4-1). The target remediation areas or volumes were also considered while developing the alternatives. This process ensured the development of a range of alternatives from those involving complete removal of Ra-226 contaminated soil posing unacceptable risk to human health to those involving little or no treatment but providing protection to human health by minimizing unacceptable exposure to Ra-226. The alternatives include:

- Alternative 1: No Action
- Alternative 2: Asphalt Cap Plus Institutional Controls and Access Restrictions
- Alternative 3: Excavation and Off-site Disposal

Each of these alternatives is described in detail in the following sections.

4.1 ALTERNATIVE 1: NO-ACTION

The NCP (40 C.F.R. § 300.430 [e][6]) requires that the no-action alternative be developed and evaluated in the FS. This alternative provides a baseline condition for comparing other alternatives. Under the no-action alternative, none of the GRAs, including institutional controls/access restrictions, containment, immobilization, removal, volume reduction, or disposal would be implemented at Units 1 and 4 of Site 8. The environmental conditions and human health risks at Units 1 and 4 would essentially be the same as presented in Section 2 of this FS. The only mechanism acting to reduce the concentrations of Ra-226 in the soil will be radioactive decay.

4.2 ALTERNATIVE 2: ASPHALT CAP PLUS INSTITUTIONAL CONTROLS AND ACCESS RESTRICTIONS

Alternative 2 would include construction of an asphalt cap over an area of approximately 15,000 square feet in the central part of Unit 1. This area consists of a portion of Unit 1 where Ra-226 was detected at concentrations posing unacceptable risk to human health (see Figures 2-3 and 2-4). To ensure protection, radiological surveys will be conducted during construction of the cap and any additional hot spots of Ra-226 in other portions of Unit 1 will be excavated and consolidated in the capping area.

The cap will be designed and constructed for longevity and efficient drainage, minimize erosion that could expose contaminated soil and contribute to Ra-226 migration, and inhibit biotic and inadvertent human intrusion. The cap will provide shielding against gamma radiation and will also act as a barrier to confine and reduce emanation of radon. Exposure pathway modeling will be conducted using pertinent exposure pathways based on institutional controls (also a component of this alternative) and Ra-226 concentrations present at Units 1 and 4 to estimate the thickness of the asphalt cover required to provide adequate protection to future land owners/users. The exact specifications of capping materials, cap design, and construction details will be identified during the remedial design phase.

In addition to constructing a cap in the central and northeastern portion of Unit 1, asphalt pavement will also be provided in the remaining areas of Units 1 and 4 (except in the area already covered with asphalt pavement). The purpose of this pavement is to ensure compatibility and act as a buffer zone around the perimeter of the central cap. Since the objective of this pavement is not to provide protection against unacceptable risk due to Ra-226, the design of this pavement, including its

thickness, will not be based on human-health protectiveness considerations. This pavement would be designed and constructed based on standard construction specifications and practices, and to provide efficient conveyance of surface drainage from the central cap.

The capping system would be combined with institutional controls consisting of land-use restrictions to ensure the integrity of the cap and limit exposure to future landowner(s) and/or user(s). The land-use restrictions would prohibit activities that lead to unacceptable exposure to human health, including but not limited to the use of the site for residential purposes, and restrictions on activities such as excavation and any other land-disturbing activities that may adversely impact the cover. The access restrictions may be in the form of warning signs and permanent markers used to deter unauthorized entry or use of the site.

Cap integrity monitoring and radiological survey programs would be established to ensure the functionality of the cover and identify any maintenance requirements. The cap integrity monitoring would include inspection for cracks, erosion, and other observable degradation. Institutional controls would also be evaluated for adequacy, effectiveness, and necessity, during each 5-year review of the remedial actions.

4.3 ALTERNATIVE 3: EXCAVATION AND OFF-SITE DISPOSAL

Alternative 3 would include excavation of soil at Units 1 and 4 so that the residual Ra-226 concentrations do not exceed the release criteria established based on the RAOs. The excavated soil will be disposed at a commercial facility licensed to receive Ra-226 contaminated soil. This alternative will include radiological surveys including, remedial action support surveys and a final status survey to demonstrate that the release criteria have been attained. The MARSSIM will be used as guidance for planning, implementing, and evaluating radiological surveys.

The release criteria and a description of the various components of the selected action are provided in the following sections.

4.3.1 Target Cleanup Goal and DCGL

A target cleanup goal and DCGL of 1 pCi/g above background has been established for Ra-226. This cleanup goal was established based on the risk and dose modeling, and ALARA analysis. The risk and dose evaluation indicated that a Ra-226 concentration of 1 pCi/g above background satisfies the NRC dose criteria of 25 mrem/y and results in a risk within an acceptable NCP risk range of 10^{-6} to 10^{-4}, for a residential (unrestricted release) scenario. Additionally, based on the cost-benefit analysis this concentration of Ra-226 is ALARA.

The target cleanup goal for Ra-226 of 1 pCi/g above background complies with the requirements of 40 C.F.R. § 192.12(b)(1) and (2) that stipulates concentration limits for radon decay products (0.02 WL) and gamma radiation (20 microroentgens per hour) in a habitable building. This was confirmed using a screening-level exposure pathway modeling conducted for a habitable building using U.S. Department of Energy and NRC-sponsored dose assessment software RESRAD Build Version 3.22. RESRAD Build computer code was run to calculate external dose (due to gamma radiation) and the radon decay product dose from a total Ra-226 concentration of 2.05 pCi/g (1 pCi/g plus Station background) in soil up to a depth of 15 centimeters (cm) bgs. The scenario was set to assess the dose at 1 meter above grade in the center of a building with a floor area of 5,670 square meters (equal to area encompassed by Units 1 and 4), and a ceiling height of 2.5 meters. The floor thickness was set to zero cm to represent the most conservative case where there is no slab to potentially reduce the diffusion of radon into the building space. All other values were left at their

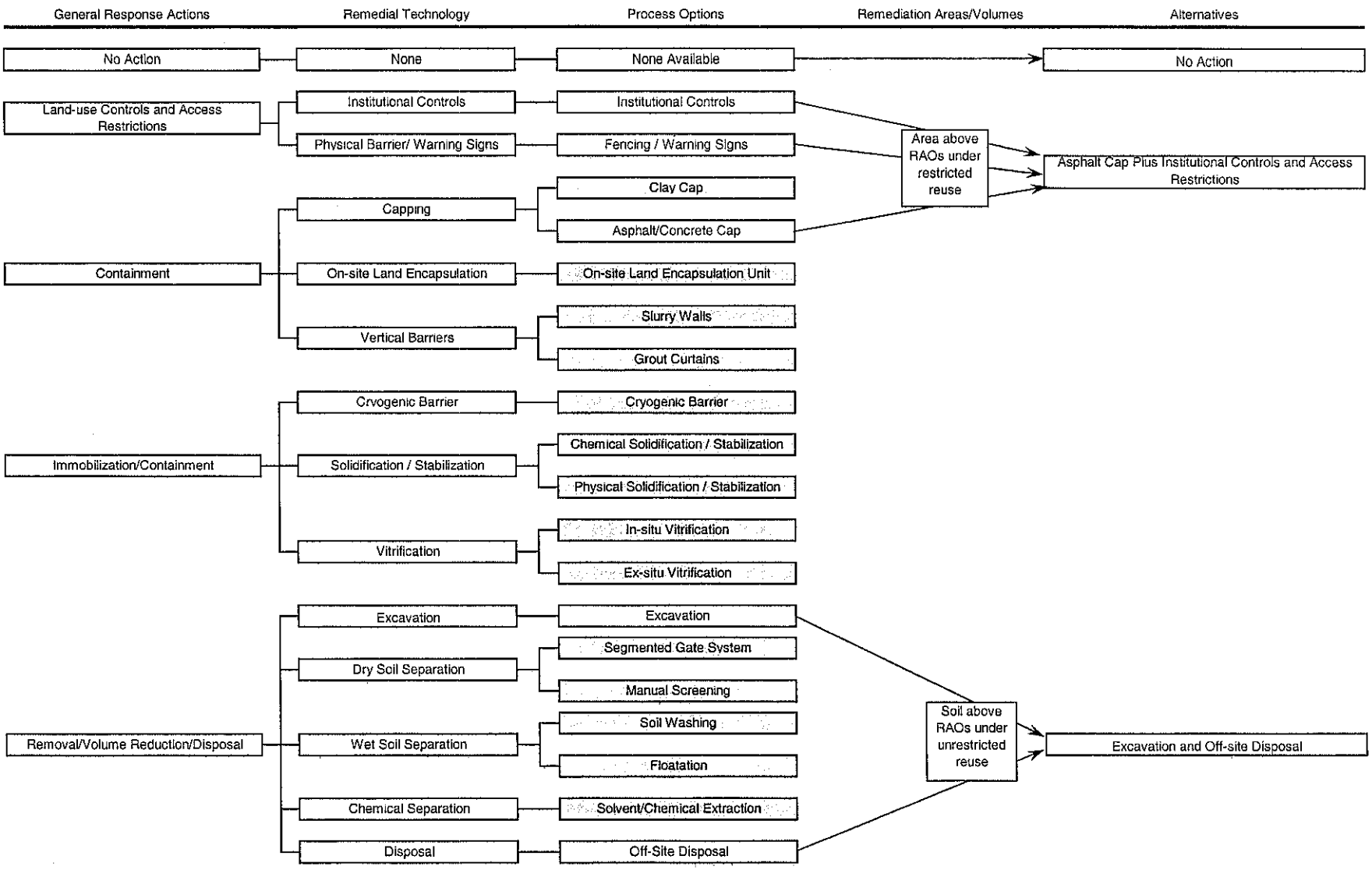


Figure 4-1: Development of Remedial Action Alternatives

default values. Using these input parameters, the radon decay product concentration was calculated to be 0.0002 WL. The external dose due to gamma radiation was estimated to be 10.5 mrem/y. This external dose is equivalent to gamma radiation level of 1.2 microroentgens per hour based on the following assumptions: 1 rem is approximately equal to 1 roentgen for tissue, and 100 percent occupancy factor in a habitable building, or 8760 hours per year. These results indicate that even for highly conservative exposure scenarios and parameters, the site-specific cleanup goal for Ra-226 results in an external dose and the radon dose at a small percentage of the limits stipulated in 40 C.F.R. § 192.12(b)(1) and (2).

4.3.2 Excavation of Ra-226 Contaminated Soil

Contaminated soil with Ra-226 above the target cleanup goal will be excavated in phases from Units 1 and 4 of Site 8. During *Phase I* removal, Units 1 and 4 will be divided into a grid, and locations with elevated Ra-226 concentrations (observed during previous investigations) will be reacquired. Soil will be manually removed at these locations and placed in appropriate containers. Following the *Phase I* soil removal, subsequent removal of Ra-226 contaminated soil will be conducted in 3- to 6-inch depth increments (*Phase II removal*) and will be based on remedial action support surveys. The remedial action support surveys will be conducted using field instrumentation sensitive to gamma activity to identify areas of elevated Ra-226, and to determine when the site is ready for final status survey.

If the remedial action support survey observations show that Ra-226 concentrations are less than 1 pCi/g above background, a final status survey will be conducted by collecting a statistically valid number of samples and analyzing them using a laboratory-grade gamma spectroscopy system. If the remedial action support surveys are conducted in a manner consistent with final status surveys, then the results of remedial action support survey will be used as final status survey. If the survey data show that the release criteria have not been attained, the top 3 to 6 inches of soil will be removed from the locations with elevated Ra-226 concentrations (*Phase III removal*), followed by collection of soil samples in the newly excavated locations. This process will be carried out iteratively until it is demonstrated that the release criteria have been attained at Units 1 and 4.

4.3.3 Disposal of Contaminated Soil

The excavated soil from Units 1 and 4 will be stored in appropriate containers and disposed at a commercial facility licensed to receive Ra-226 contaminated soil.

5. DETAILED ANALYSIS OF ALTERNATIVES

The NCP (40 C.F.R. § 300.430 [e][9][i] and [ii]) requires that a detailed analysis of remedial alternatives be conducted during the FS based on the nine evaluation criteria identified in 40 C.F.R. § 300.430 (e)(9)(iii). The results of the detailed analysis provide the basis for identifying a preferred alternative and preparing the proposed plan.

The detailed analysis of remedial alternatives for Ra-226 contaminated soil at Units 1 and 4 of Site 8 is presented in the following sections. Section 5.1 provides a brief description of each of the nine evaluation criteria. Section 5.2 provides an assessment and a summary profile of each alternative against the evaluation criteria. Section 5.3 presents comparative analysis among the alternatives to assess the relative performance of each alternative with respect to each evaluation criteria.

5.1 EVALUATION CRITERIA

The nine evaluation criteria identified in the NCP (40 C.F.R. § 300.430 [e][9][iii]) are categorized into three groups: threshold criteria, primary balancing criteria, and modifying criteria. The threshold criteria must be satisfied by each alternative and relate directly to statutory findings that must ultimately be made in the ROD. The two threshold criteria include:

- Overall protection of human health and the environment, and
- Compliance with ARARs

The primary balancing criteria are used to weigh major tradeoffs among alternatives and include the following:

- Long-term effectiveness and permanence,
- Reduction of toxicity, mobility, or volume through treatment,
- Short-term effectiveness,
- Implementability, and
- Cost

The modifying criteria are taken into account following comment on the FS report and proposed plan, and are addressed once a final decision is being made and the ROD is being prepared. The modifying criteria include:

- State acceptance, and
- Community acceptance

Each of the nine evaluation criteria is summarized in the following sections.

5.1.1 Overall Protection of Human Health and the Environment

Under this criterion, the alternatives are assessed to determine whether they can adequately protect human health and the environment, in both the short- and long- term, from unacceptable risks posed by contaminants present at the site by eliminating, reducing, or controlling exposures to contaminant levels established during development of remediation goals. Overall protection of human health and the environment draws on the assessments of other evaluation criteria, especially long-term effectiveness and permanence, short-term effectiveness, and compliance with ARARs.

5.1.2 Compliance with ARARs

Under this criterion, the alternatives are assessed to determine whether they attain applicable or relevant and appropriate requirements under federal environmental laws and state environmental or facility siting laws or provide grounds for invoking a waiver.

5.1.3 Long-term Effectiveness and Permanence

The evaluation of alternatives under this criterion addresses the results of a remedial action in terms of risk remaining at the site after response objectives have been met. The primary focus of this evaluation is the extent and effectiveness of the controls that may be required to manage the risk posed by treatment residuals and/or untreated wastes. Factors that are considered, as appropriate, include the following:

- Magnitude of residual risk remaining from untreated waste or treatment residuals remaining at the conclusion of the remedial activities.
- Adequacy and reliability of controls such as containment systems and institutional controls that are necessary to manage treatment residuals and untreated waste.

5.1.4 Reduction of Toxicity, Mobility, or Volume through Treatment

This criterion evaluates alternatives based on the degree to which they employ recycling or treatment that reduces toxicity, mobility, or volume. This includes how treatment is used to address the principal threats posed by the site. Factors that are considered include the following:

- The treatment or recycling processes the alternatives employ and materials they will treat;
- The amount of contaminants that will be destroyed, treated, or recycled;
- The degree of expected reduction in toxicity, mobility, or volume of the waste due to treatment or recycling and the specification of which reductions are occurring;
- The degree to which the treatment is irreversible;
- The type and quantity of residuals that will remain following treatment, considering the persistence, toxicity, mobility, and propensity to bioaccumulate such hazardous substances and their constituents; and
- The degree to which treatment reduces the inherent hazards posed by principal threats at the site.

5.1.5 Short-term Effectiveness

Under this criterion, alternatives are evaluated with respect to their effects on human health and the environment during implementation of the remedial action. The short-term impacts of alternatives are assessed considering the following:

- Short-term risks that might be posed to the community during implementation of an alternative;
- Potential impacts on workers during remedial action and the effectiveness and reliability of protective measures;
- Potential environmental impacts of the remedial action and the effectiveness and reliability of mitigative measures during implementation; and

- Time until protection is achieved.

5.1.6 Implementability

The assessment for implementability of the alternatives is based on the following factors:

- Technical feasibility, including technical difficulties and unknowns associated with the construction and operation of a technology, the reliability of the technology, ease of undertaking additional remedial actions, and the ability to monitor the effectiveness of the remedy.
- Administrative feasibility, including activities needed to coordinate with other offices and agencies and the ability and time required to obtain any necessary approvals and permits from other agencies (for off-site actions);
- Availability of services and materials, including the availability of adequate off-site treatment, storage capacity, and disposal capacity and services; the availability of necessary equipment and specialists, and provisions to ensure any necessary additional resources; the availability of services and materials; and availability of prospective technologies.

5.1.7 Cost

The types of costs that are assessed include the following:

- Capital costs, including both direct and indirect costs;
- Annual operation and maintenance (O&M) costs; and
- Net present value of capital and O&M costs.

5.1.8 State Acceptance

The criterion assesses the state acceptance by considering the following:

- The State's position and key concerns related to the preferred alternative and other alternatives; and
- State comments on ARARs or the proposed use of waivers.

5.1.9 Community Acceptance

This assessment includes determining which components of the alternatives interested persons in the community support, have reservations about, or oppose. This assessment may not be completed until comments on the proposed plan are received.

5.2 Individual Analysis of Alternatives

A discussion of individual analysis of each of the alternatives with respect to the evaluation criteria described in Section 5.1 is described in the following sections and a summary is presented in Table 5-1.

5.2.1 Alternative 1: No-Action

The inclusion of the no-action alternative is required under the NCP (40 C.F.R. § 300.430 [e][6]) to act as a baseline condition for assessing other alternatives. Under the no-action alternative, none of the GRAs including institutional controls/access restrictions, containment, immobilization, removal,

volume reduction, or disposal would be implemented at Units 1 and 4 of Site 8. The environmental conditions and human health risks at Units 1 and 4 would essentially be the same as presented in Section 2 of this FS. The only mechanism acting to reduce the concentrations of Ra-226 in the soil will be radioactive decay.

5.2.1.1 Overall Protection of Human Health and the Environment

Since no remedial activities will be performed under Alternative 1 for removing, stabilizing, containing, or reducing exposure to Ra-226 contaminated soil at Site 8, this alternative does not reduce risks to human health. As mentioned in Section 2 of this FS, present risks due to Ra-226 concentrations at Units 1 and 4 of Site 8 are unacceptable. This alternative also allows for continued migration of Ra-226 in soil primarily by wind erosion and fugitive dust.

5.2.1.2 Compliance with ARARs

Since no-action entails no remedial action, ARARs are not triggered. Therefore, a discussion of compliance with ARARs is not appropriate for this alternative.

5.2.1.3 Long-term Effectiveness and Permanence

This alternative affords little long-term effectiveness and permanence since it includes no controls for preventing or reducing exposure to Ra-226. All current and potential future risks would remain under this alternative. Radioactive decay of Ra-226 will be the only mechanism acting to reduce concentrations of Ra-226 and its daughter products at a very slow rate since the radioactive half-life for Ra-226 is 1,600 years

5.2.1.4 Reduction of Toxicity, Mobility, or Volume Through Treatment

The no-action alternative provides no reduction in toxicity, mobility, or volume of the contaminated soil at Units 1 and 4 of Site 8 through treatment.

5.2.1.5 Short-term Effectiveness

Since no remedial activities will be performed as a part of the no-action alternative, no short-term effectiveness is associated with this alternative. However, since no action will be taken under this alternative, no additional risks will be posed to the community, the workers, or the environment.

5.2.1.6 Implementability

There are no implementability issues associated with this alternative since no action would be taken.

5.2.1.7 Cost

There are no costs associated with this alternative since no remedial activities will be performed.

5.2.1.8 State Acceptance

The state acceptance of this alternative will be evaluated after regulatory agencies have reviewed the Draft FS.

5.2.1.9 Community Acceptance

Community acceptance of this alternative will be reviewed following the public review process.

Table 5-1: Detailed Analysis of Alternatives Summary

Criteria	Alternative 1– No action	Alternative 2: Asphalt Cap Plus Institutional Controls and Access Restrictions	Alternative 3: Excavation and Off-site Disposal
Overall Protection of Human Health and the Environment	Does not reduce risks to human health since no remedial activities will be performed for removing, stabiiizing, containing, or reducing exposure to Ra-226 contaminated soil at Site 8. Allows for continued migration of Ra-226 in soil primarily by wind erosion and fugitive dust. The risks at Units 1 and 4 remain the same as presented in Section 2 of this.	Protects human health by acting as a barrier between the Ra-226 contaminated soil and the surface environment, thus preventing human contact with the contaminated soil. The cap will also prevent migration of Ra-226 by wind erosion and fugitive dust. Institutional controls in the form of land-use restrictions will prevent exposure to contaminated soil by prohibiting activities that lead to unacceptable exposure to human health and preventing inadvertent damage to the cap. However, since this alternative does not remove contaminated material from the site, the risk due to exposure to contaminated media is not entirely eliminated since prevention of contact is not assured.	Reduces human-health risk since Ra-226 contaminated soil at Site 8 Units 1 and 4 will be removed.
Compliance with ARARs	Since no-action entails no remedial action, ARARs are no triggered. Therefore, a discussion of compliance with ARARs is not appropriate for this alternative	Complies with all the identified ARARs	Complies with all the identified ARARs.
Long-Term Effectiveness and Permanence	Affords little long-term effectiveness and permanence since it includes no controls for preventing or reducing exposure to Ra-226. All current and potential future risks would remain under this alternative. Radioactive decay of Ra-226 will be the only mechanism acting to reduce concentrations of Ra-226 and its daughter products at a very slow rate since radioactive half-life for Ra-226 is very long (1,600 years).	Does not remove Ra-226 contaminated soil from Units 1 and 4 of Site 8; however, will impede direct exposure and further migration of Ra-226. Since the contaminated soil posing unacceptable risk to human health will remain onsite for a long time (because of the long half-life of Ra-226), long-term cap-maintenance and implementation of institutional controls will be required to ensure protectiveness of the remedy. A review of remedy will be required at least every 5 years (CERCLA Section 121[c]), to ensure that remedy continues to be protective of human health. This alternative is not a permanent solution since Ra-226 is not treated or removed from the site and the potential for inadvertent exposure of on-site receptors to Ra-226 cannot be entirely eliminated	Provides long-term effectiveness at Site 8, Units 1 and 4 since the contaminated soil will be removed. This alternative is a permanent solution because soil with Ra-226 concentrations presenting unacceptable risk to human health will be removed from the site.
Reduction in Toxicity, Mobility, and Volume	Does not provide reduction in toxicity, mobility, or volume of the contaminated soil at Units 1 and 4 of Site 8 through treatment.	Does not reduce toxicity due to Ra-226 or volume of Ra-226 contaminated soil. Capping will reduce the mobility of Ra-226 via wind or surface water erosion. Any reduction in toxicity will only occur due to radioactive decay of Ra-226	This alternative does not reduce toxicity and mobility of Ra-226 contaminated soil through treatment. However, since this alternative involves excavation and off-site disposal, the toxicity to on-site receptors and mobility of Ra-226 at Units 1 and 4 of Site 8 is reduced. The use of remedial action support surveys during excavation to identify the areas of elevated Ra-226 will reduce the volume of the excavated soil requiring disposal.
Short-Term Effectiveness	Since no remedial activities will be performed as a part of no-action alternative, no additional risks will be posed to the community, the workers, or the environment as a result of the implementation of this alternative	During cap construction, site-workers and surrounding communities may be exposed to the contaminated soil, fugitive dust and gas emissions. The risk of exposure will increase if excavation and waste consolidation from other part of the site is required.	Excavation, temporary storage, and transportation of Ra-226 contaminated soil at Units 1 and 4 of Site 8 may expose site-workers and surrounding communities to the contaminated soil, fugitive dust, and gas emissions
Implementability	There are no implementability issues associated with this alternative since no action would be taken	Mature, well-known technology that can be readily implemented using widely available commercial services, materials, and equipment. Since the materials and equipment are readily available, no technical difficulties or delays are expected in implementation. No special permits or approvals are required for implementing this alternative.	Mature, well-known technology that can be readily implemented using widely available commercial services, materials, and equipment. Since the materials and equipment are readily available, no technical difficulties or delays are expected in implementation. No special permits or approvals are required for implementing this alternative.
State Acceptance	The state acceptance of this alternative will be evaluated after regulatory agencies have reviewed the FS.	The state acceptance of this alternative will be evaluated after regulatory agencies have reviewed the FS.	The state acceptance of this alternative will be evaluated after regulatory agencies have reviewed the FS.
Community Acceptance	Community acceptance of this alternative will be reviewed following the public review process.	Community acceptance of this alternative will be reviewed following the public review process.	Community acceptance of this alternative will be reviewed following the public review process.
Cost ($)	$0	$664,000	$1,702,000

5.2.2 Alternative 2: Asphalt Cap Plus Institutional Controls and Access Restrictions

Alternative 2 includes construction of an asphalt cap in the central part of Unit 1 to reduce exposure to Ra-226 contaminated soil. Institutional controls consisting of land-use restrictions will also be implemented to ensure the integrity of the cap and limit exposure to future landowner(s) and/or user(s). A complete description of this alternative is presented in Section 4.2.

5.2.2.1 *Overall Protection of Human Health and the Environment*

Capping will protect human health by acting as a barrier between the Ra-226 contaminated soil and the surface environment, thus preventing human contact with the contaminated soil. The capping will also prevent migration of Ra-226 by wind erosion and fugitive dust. Institutional controls in the form of land-use restrictions will prevent exposure to contaminated soil by prohibiting activities that lead to unacceptable exposure to human health and preventing inadvertent damage to the cap. However, since this alternative does not remove contaminated material from the site, the risk due to exposure to contaminated media is not entirely eliminated since prevention of contact is not assured.

5.2.2.2 *Compliance with ARARs*

Construction of an asphalt cap under Alternative 2 will comply with the federal chemical-specific ARARs as follows:

- RCRA requirements for hazardous waste evaluation per Cal. Code Regs. tit. 22 § 66261.21, 66261.22(a)(1), 66261.23, 66261 24(a)(1), and 66261.100
- RCRA groundwater protection standards per Cal. Code Regs. tit. 22 § 66264.94 (a)(1) and (3), (c), (d), and (e)
- NRC's radiological criteria for license termination under restricted reuse per 10 C.F.R. § 20.1403 (a) and (b).
- Standards stipulated for radon decay products and gamma radiation levels per 40 C.F.R. § 192.12(b)(1) and (2).

Construction of an asphalt cap under Alternative 2 will comply with the state chemical-specific ARARs as follows:

- Non-RCRA state-regulated hazardous waste evaluation per Cal. Code Regs. tit. 22 § 66261.22(a)(3) and (4), 66261.24(a)(2)–(a)(8), 66261.101, 66261.3(a)(2) (C), and 66261.3(a)(2) (F)
- Classification of waste as designated, nonhazardous, or inert waste per Cal. Code Regs. tit. 27, §§ 20210, 20220, and 20230

Alternative 2 will comply with the following federal action-specific ARARs:

- SCAQMD requirements for air emissions per SCAQMD rules 401, 403, 404, and 405

Alternative 2 will comply with the following state action-specific ARARs:

- California Department of Fish and Game requirements per California Fish and Game Code § 3005; 3503; 3503.5; 3800; and 4150, and Cal. Code Regs. tit. 14 § 472.

No federal or state location-specific ARARs were identified for this alternative. A comprehensive discussion of the ARARs is presented in Appendix C.

5.2.2.3 LONG-TERM EFFECTIVENESS AND PERMANENCE

Capping will not remove Ra-226 contaminated soil from Units 1 and 4 of Site 8; however, it will prevent direct exposure and further migration of Ra-226. Proper maintenance of the asphalt cap and implementation of institutional controls will be required to ensure cap integrity and long-term effectiveness of this alternative in protecting human health. Failure to address the degradation of cap in the long term due to weathering, cracking, subsidence, or other deterioration could result in unacceptable exposure to human health. Since the contaminated soil posing unacceptable risk to human health will remain onsite for a long time (because of the long half-life of Ra-226), long-term cap-maintenance and implementation of institutional controls will be required. A review of the remedy will have to be conducted at least every 5 years (CERCLA Section 121[c]) to ensure that the remedy continues to be protective of human health because this alternative would leave hazardous substances on site. This alternative is not a permanent solution since Ra-226 is not treated or removed from the site and the potential for inadvertent exposure of on-site receptors to Ra-226 cannot be entirely eliminated.

5.2.2.4 REDUCTION OF TOXICITY, MOBILITY, OR VOLUME

Capping will not reduce toxicity due to Ra-226 or volume of Ra-226 contaminated soil. Capping will reduce the mobility of Ra-226 via wind or surface water erosion. Any reduction in toxicity will only occur due to radioactive decay of Ra-226.

5.2.2.5 SHORT-TERM EFFECTIVENESS

During cap construction, site workers and surrounding communities may be exposed to the contaminated soil, fugitive dust and gas emissions. The risk of exposure will increase if excavation and waste consolidation from other part of the site is required. Various procedures and engineering controls will have to be implemented during the construction phase to reduce short-term risks to community and radiation workers. These procedures and engineering controls will include spraying water during earth-moving and grading operations, use of personnel protective equipment to minimize direct contact with Ra-226 contaminated soil, and conducting daily safety briefings.

Heavy equipment used in cap construction will conform to the specifications of the California Occupation Safety and Health Administration (Cal-OSHA). Heavy equipment will be operated only by authorized and trained personnel, and will be routinely inspected for satisfactory operations of safety features. The time required for achieving remedial action objectives by this alternative will be approximately 2 months.

5.2.2.6 IMPLEMENTABILITY

Capping is a well-known technology that can be readily implemented using widely available commercial services, materials, and equipment. Since the materials and equipment are readily available, no technical difficulties or delays are expected in implementation. No special permits or approvals are required for implementing this alternative.

5.2.2.7 COST

The cost estimate for Alternative 2 was generated using the Remedial Action Cost Engineering Requirements (RACER™ 2005) system Version 7.0.1. Table 5-2 presents the estimated cost for implementation of Alternative 2.

The capital costs for Alternative 2 include:

- Remedial design cost

- Cost of construction of an asphalt concrete cap over an area of 15,000 square feet
- Cost of construction of an asphalt pavement over the remaining area (44,800 square feet) of Units 1 and 4
- Cost of conducting radiological surveys and sampling during construction of an asphalt cap
- Cost for implementing institutional controls
- Professional labor cost

The periodic costs for Alternative 2 include cost for conducting 5-year reviews to ensure protectiveness of the remedy. The estimated net present worth of Alternative 2 is $664,000

Table 5-2: Cost Estimate Summary - Alternative 2

CAPITAL COST		
Item #	**Component**	**Total Cost**
1.	Capping	$130,000[a]
2.	Asphalt Pavement	$84,000
3.	Radiological Surveys and Sampling	$35,500
Subtotal		$249,500
Contingency (20 percent)[b]		$49,900
Subtotal		$299,400
4.	Institutional Controls	$84,500
5.	Professional Labor	$183,200
6.	Remedial Design	$20,000
Escalation[c]		$8,800
Total Capital Cost		**$596,000[d]**
PERIODIC COST		
7.	Five-year Reviews[e]	$189,900
Escalation[c]		$85,500
Total Periodic Cost		**$275,000[d]**
Present Value of Periodic Cost[f]		**$68,000[d]**
TOTAL PRESENT VALUE[f]		**$664,000[d]**

Notes:
[a] The capital cost of components includes contractor markups, or overhead and profit. RACER 2005 Markup Template was used to calculate Marked-up Cost. The listed costs do not include escalation.
[b] 20 percent contingency was assumed to cover unknowns, unforeseen circumstances, or unanticipated factors that are not possible to evaluate from the data on hand.
[c] Escalation modifies project cost from the current date of the estimate (March 2005) to the date when cost will actually be incurred (February 2006). RACER uses escalation factors to account for inflation and adjust the price from current dollars to the future estimated cost on the date when work is expected to begin. All escalation factors in RACER are obtained from the Inflation Indices on the Secretary of the Air Force Financial Management and Comptroller's (SAF/FMC) website.
[d] The costs were rounded of to nearest thousands
[e] The estimate presented is for a total of 6 five-year reviews for a period of 30 years.
[f] The present value analysis was performed for a period of 30 years, using a discount rate of 7 percent. The value reflects the net present worth as of February 2006.

5.2.2.8 *STATE ACCEPTANCE*

The state acceptance of this alternative will be evaluated after regulatory agencies have reviewed the Final FS.

5.2.2.9 COMMUNITY ACCEPTANCE

Community acceptance of this alternative will be reviewed following the public review process

5.2.3 Alternative 3: Excavation and Off-site Disposal

Alternative 3 includes excavation of contaminated soil exceeding the target cleanup goal for Ra-226. The excavated soil will be disposed at a commercial facility licensed to receive Ra-226 contaminated soil. A complete description of this alternative is presented in Section 4.3.

5.2.3.1 OVERALL PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT

Alternative 3 will reduce the human-health risk at the site since the contaminated soil at Site 8 Units 1 and 4 will be removed. Therefore, this alternative is considered protective of human health.

5.2.3.2 COMPLIANCE WITH ARARS

Alternative 3 will comply with the federal chemical-specific ARARs as follows:

- RCRA requirements for hazardous waste evaluation per Cal. Code Regs. tit. 22 § 66261.21, 66261.22(a)(1), 66261.23, 66261.24(a)(1), and 66261.100
- RCRA groundwater protection standards per Cal. Code Regs. tit. 22 § 66264.94 (a)(1) and (3), (c), (d), and (e)
- NRC's radiological criteria for license termination under unrestricted reuse per 10 C.F.R. § 20.1402
- Concentration limits for cleanup of Ra-226 per 40 C.F.R. § 192.12(a), 192.32(b)(2), and 192.41
- Standards stipulated for radon decay products and gamma radiation levels per 40 C.F.R. § 192.12(b)(1) and (2).

Alternative 3 will comply with the state chemical-specific ARARs as follows:

- Non-RCRA state-regulated hazardous waste evaluation per Cal. Code Regs. tit. 22 § 66261.22(a)(3) and (4), 66261.24(a)(2)–(a)(8), 66261.101, 66261.3(a)(2) (C), and 66261.3(a)(2) (F)
- Classification of waste as designated, nonhazardous, or inert waste per Cal. Code Regs. tit. 27, §§ 20210, 20220, and 20230

Alternative 3 will comply with the following federal action-specific ARARs:

- RCRA requirements for generation and storage of hazardous waste per Cal. Code Regs. tit. 22 § 66262.10(a), 66262.11, 66264.13(a) and (b), 66262.34, 66264.171, 66264.172, 66264.173, 66264.174, 66264.175(a) and (b), and 66264.178; and 40 C.F.R. § 264.554(d)(1)(i–ii) and (d)(2), (e), (f), (h), (i), (j), and (k).
- RCRA requirements for clean closure per Cal. Code Regs. tit. 22 § 66264.111(a) and (b).
- SCAQMD requirements for air emissions per SCAQMD rules 401, 403, 404, and 405

Alternative 3 will comply with the following state action-specific ARARs:

- California Department of Fish and Game requirements per California Fish and Game Code § 3005; 3503; 3503.5; 3800; and 4150, and Cal. Code Regs. tit. 14 § 472.

5.2.3.3 LONG-TERM EFFECTIVENESS AND PERMANENCE

Alternative 3 will provide long-term effectiveness at Site 8, Units 1 and 4 since the contaminated soil will be removed. This alternative is a permanent solution because soil with Ra-226 concentrations presenting unacceptable risk to human health will be removed from the site.

5.2.3.4 REDUCTION OF TOXICITY, MOBILITY, OR VOLUME

This alternative does not reduce toxicity and mobility of Ra-226 contaminated soil through treatment. However, since this alternative involves excavation and off-site disposal, the toxicity to on-site receptors and mobility of Ra-226 at Units 1 and 4 of Site 8 is reduced. The use of remedial action support surveys during excavation to identify the areas of elevated Ra-226 will reduce the volume of the excavated soil requiring disposal.

5.2.3.5 SHORT-TERM EFFECTIVENESS

Alternative 3 includes excavation, temporary storage, and transportation of Ra-226 contaminated soil at Units 1 and 4 of Site 8. These activities may expose site workers and surrounding communities to the contaminated soil, fugitive dust, and gas emissions. Various procedures and engineering controls will have to be implemented during the construction phase to reduce short-term risks to community and radiation workers. These procedures and engineering controls will include spraying water during excavation and earth-moving operations, use of personnel protective equipment to minimize direct contact with Ra-226 contaminated soil, and conducting daily safety briefings.

Heavy equipment used in excavation and earth-moving operations will conform to the specifications of the Cal-OSHA. Heavy equipment will be operated only by authorized and trained personnel, and will be routinely inspected for satisfactory operations of safety features. The time required for achieving RAOs using this alternative will be approximately 2 months, and will include site preparation, excavation, loading, and off-site transportation of contaminated soil.

5.2.3.6 IMPLEMENTABILITY

Excavation is a well-known technology that can be readily implemented using widely available commercial services, materials, and equipment. Since the materials and equipment are readily available, no technical difficulties or delays are expected in implementation. No special permits or approvals are required for implementing this alternative.

5.2.3.7 COST

RACER™2005 system Version 7.0.1 was used to generate cost estimate for Alternative 3. Table 5-3 presents the estimated cost for implementation of Alternative 3.

Since Alternative 3, includes removal of Ra-226 contaminated soil exceeding the release criteria and disposal at an off-station facility, no O&M costs are associated with this alternative. The capital costs for Alternative 3 include:

- Remedial design cost.
- Cost of excavating Ra-226 contaminated soil. The estimated volume of contaminated soil is 1,250 bcy.
- Cost of backfilling the excavation area with clean fill material (for site safety).

- Cost of remedial action support surveys and final status surveys to demonstrate that the cleanup has been achieved at the site.
- Professional labor cost.
- Cost of preparing closure documentation

5.2.3.8 STATE ACCEPTANCE

The state acceptance of this alternative will be evaluated after regulatory agencies have reviewed the Final FS.

5.2.3.9 COMMUNITY ACCEPTANCE

Community acceptance of this alternative will be reviewed following the public review process.

Table 5-3: Cost Estimate Summary - Alternative 3

CAPITAL COST		
Item #	**Component**	**Total Cost**
1.	Excavation and Backfilling	$42,000[a]
2.	Radiological Surveys and Sampling	$57,100
3.	Off-site Transportation and Waste Disposal	$876,000[b]
Subtotal		$975,100
Contingency (20 percent)[c]		$195,010
Subtotal		$1,170,120
5.	Professional Labor	$457,000
6.	Remedial Design	$29,000
7.	Site Closure Documentation	$23,600
Escalation[d]		$22,300
Total Capital Cost		**$1,702,000[e]**
TOTAL PRESENT VALUE[f]		**$1,702,000[e]**

Notes:
[a] The capital cost of components includes contractor markups, or overhead and profit. RACER 2005 Markup Template was used to calculate Marked-up Cost. The listed costs do not include escalation.
[b] The transportation and disposal cost was based on following assumptions: (i) Volume of soil requiring disposal = 1562 cy (assuming expansion factor of 1.25); (ii) Distance to off-site disposal facility = 900 miles (one-way); and (iii) Disposal fee = $250 per cy (based on a quotation).
[c] 20 percent contingency was assumed to cover unknowns, unforeseen circumstances or unanticipated factors that are not possible to evaluate from the data on hand.
[d] Escalation modifies project cost from the current date of the estimate (March 2005) to the date when cost will actually be incurred (February 2006). RACER uses escalation factors to account for inflation and adjust the price from current dollars to the future estimated cost on the date when work is expected to begin. All escalation factors in RACER are obtained from the Inflation Indices on the Secretary of the Air Force Financial Management and Comptroller's (SAF/FMC) website.
[e] The costs were rounded off to nearest thousands.
[f] The present value of the alternative is same as the capital cost since all the incurred costs are capital costs. The value reflects the net present worth as of February 2006.

5.3 COMPARATIVE ANALYSIS OF ALTERNATIVES

The comparative analysis of alternatives constitutes evaluation of alternatives in relation to one another for each of the nine NCP evaluation criteria. The purpose of this analysis is to identify the relative advantages and disadvantages of each alternative.

The following sections present the comparative analysis of the three remedial alternatives developed for Site 8, Units 1 and 4. Table 5-4 presents the summary of the comparative analysis.

5.3.1 Overall Protection of Human Health and the Environment

Alternative 1 is not protective of human health and the environment since it does not include any action to reduce exposure or potential environmental migration of Ra-226 at Units 1 and 4 of Site 8. Alternative 2 will provide reduction in risk by isolating and preventing human contact with Ra-226 contaminated soil by construction of an asphalt cap. Although the cap reduces potential migration of Ra-226, prevention of contact with the contaminated soil or release of Ra-226 to the environment is not assured. Therefore, Alternative 2 is considered only moderately protective of human health and the environment. Alternative 3 is considered fully protective of human health and the environment at Units 1 and 4, since it involves complete removal of Ra-226 contaminated soil posing unacceptable risk to human health.

5.3.2 Compliance with ARARs

Alternative 1 will not comply with any ARARs because no remedial action will be taken to reduce risks associated with contaminated soil at Site 8, Units 1 and 4. Alternative 2 will comply with ARARs pertaining to protection of human health by attaining the prescribed dose standards, air emissions due to fugitive dust, and protection of biological resources during remedial action implementation.

Alternative 3 will comply with ARARs pertaining to classification, generation, transportation, storage, and disposal of hazardous waste; air emissions due to fugitive dust; protection of human health by attaining the prescribed dose standards; and protection of biological resources during remedial action implementation

5.3.3 Long-term Effectiveness and Permanence

Alternative 1 will have very little long-term effectiveness because it includes no remedial action. Environmental conditions at Units 1 and 4 will remain essentially unchanged from those now present at the site. The only mechanism acting to reduce concentrations of Ra-226 would be radioactive decay which is a very slow process because of a long half-life (1,600 years) of Ra-226. Alternative 2 will have long-term effectiveness in preventing contact with the contaminated soil provided the asphalt cap is not damaged or removed. Similar to Alternative 1, radioactive decay will be the only process acting to reduce contaminant concentrations in the soil for Alternative 2. Therefore, Alternative 2 is only moderately effective in the long term because it does not represent permanent solution and inadvertent exposure to on-site receptors to Ra-226 cannot be entirely eliminated. Alternative 3 offers long-term effectiveness and is considered a permanent solution since the contaminants in shallow soil are physically removed from Units 1 and 4 of Site 8.

5.3.4 Reduction of Toxicity, Mobility, or Volume

Alternative 1 provides no appreciable reduction in toxicity, mobility, or volume of Ra-226 because no remedial actions will be taken. Although radioactive decay will continue to reduce Ra-226 concentrations, only slight reductions in Ra-226 toxicity and volume will be realized over a long time. Similarly, Alternative 2 does not reduce toxicity or volume beyond the slight long-term changes resulting from radioactive decay. However, capping will reduce mobility of Ra-226 via wind or surface water erosion. Under Alternative 3, the contaminated soil will be physically removed from Units 1 and 4 of Site 8; therefore, toxicity to on-site receptors and mobility of Ra-226 at the site will be substantially reduced. Additionally, the use of remedial action support surveys during

excavation to identify the areas of elevated Ra-226 will reduce the volume of the excavated soil requiring disposal.

5.3.5 Short-term Effectiveness

There is no short-term effectiveness associated with Alternative 1 since no remedial activities are performed. However, since no action will be taken under Alternative 1, no additional risks will be posed to the community, the workers, or the environment.

Alternative 2 will include construction of an asphalt cap over an area of approximately 15,000 square feet. Alternative 3 will include excavation, temporary storage, transportation, and disposal of Ra-226 contaminated soil. Both the alternatives involve activities that may expose site-workers and surrounding communities to the contaminated soil, fugitive dust, and gas emissions if the specific procedures and engineering controls are not implemented. Compared to excavation and earth-moving activities associated with Alternative 3, cap construction will cause only minor disturbance of the contaminated soil since the ground surface is already level and little site preparation work should be required prior to capping. Therefore, Alternative 2 provides better short-term effectiveness compared to Alternative 3.

5.3.6 Implementability

There are no implementability issues associated with Alternative 1 since no action will be taken. Alternative 2 includes construction of an asphalt cap and Alternative 3 includes excavation and off-site disposal of contaminated soil. Both capping and excavation are well-known technologies that can be readily implemented using widely available commercial services, materials, and equipment. No technical difficulties or delays are expected in implementation of either alternative.

5.3.7 Cost

No cost is associated with Alternative 1. The estimated total present value of Alternative 2 is $664,000. It should be noted that present value analysis for Alternative 2 was performed for an operational lifetime of 30 years. However, since the radioactive half-life of Ra-226 is long, the operational lifetime of Alternative 2 could exceed 30 years and may result in cost significantly more than estimated. The estimated total present value of Alternative 3 is $1,702,000.

5.3.8 State Acceptance

The state has not yet commented on the three alternatives proposed for Ra-226 contaminated soil at Units 1 and 4 of Site 8.

5.3.9 Community Acceptance

Community acceptance of one or more of the three alternatives proposed for Site 8, Units 1 and 4 will be assessed following the public review process.

Table 5-4: Comparative Analysis of Alternatives Summary

Criterion	Alternative 1– No action	Alternative 2: Asphalt Cap Plus Institutional Controls and Access Restrictions	Alternative 3: Excavation and Off-site Disposal
Overall Protection of Human Health and the Environment	Low Does not protect human health and the environment against exposure to contaminated soil.	Moderate Provides protection to human health and the environment provided the cap is not disturbed.	High Provides protection to human health and the environment by removing the contaminated soil from the site.
Compliance with ARARs	Low	High Complies with all the identified ARARs	High Complies with all the identified ARARs
Long-Term Effectiveness and Permanence	Low Not effective in protecting human health and the environment. No reduction in risk.	Moderate Contaminated soil is not removed, but is covered with an asphalt cap. Provides protection to human health and the environment provided the cap is not disturbed.	High Contaminated soil is removed from the site. Significantly reduces risk at the site and is considered permanent solution.
Reduction in Toxicity, Mobility, and Volume Through Treatment	Low Does not reduce toxicity, mobility, or volume.	Moderate Reduces mobility, but does not address toxicity or volume.	High Reduces mobility and volume of contaminated soil by excavation and off-site transportation. Does not address toxicity.
Short-Term Effectiveness	High No short-term effectiveness associated with this alternative since no remedial actions are performed.	Moderate Capping activities will cause only minor disturbance to the site resulting in low risk to workers and the public.	Low Excavation activities may expose workers to site contamination.
Implementability	High No implementability issues associated with this alternative since no actions are performed.	Moderate Capping activities will require moderate amount of technical and administrative effort. Institutional controls will require some additional administrative effort.	Moderate Excavation and off-site disposal activities will require average technical and administrative effort.
Cost ($)	None No cost	Low The least expensive alternative.	Moderate More expensive than Alternative 2.
State Acceptance	Will be evaluated following State review of the Final FS Addendum.	Will be evaluated following State review of the Final FS Addendum.	Will be evaluated following State review of the Final FS Addendum.
Community Acceptance	Will be evaluated following public review of the proposed plan.	Will be evaluated following public review of the proposed plan.	Will be evaluated following public review of the proposed plan.

6. REFERENCES

Agency for Toxic Substances and Disease Registry (ATSDR). 1990. *Toxicological Profile for Radium*. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service. http://www.atsdr.cdc.gov/toxprofiles/phs144.html

Bechtel National, Inc. (BNI). 1997a. *Draft Final Phase II Remedial Investigation Report, OU-3A Sites, Marine Corps Air Station, El Toro, California*. San Diego, CA: NAVFAC EFD SOUTHWEST. March.

———. 1997b. *Draft Final Phase II Feasibility Study, OU-3A Sites, Marine Corps Air Station, El Toro, California*. San Diego, CA: NAVFAC EFD SOUTHWEST.

Department of the Navy, United States (DON). 1999a. *Draft Record of Decision, Operable Unit 3A, Sites 8, 11, and 12, Marine Corps Air Station, El Toro, California*. San Diego, CA: NAVFAC EFD SOUTHWEST. June.

———. 1999b. *Proposed Plan for Cleanup at Three Shallow Soil Sites at Marine Corps Air Station El Toro*. San Diego, CA: NAVFAC EFD SOUTHWEST. May.

———. 2001. *Department of the Navy Installation Restoration Program Manual (Draft), 2001 Update*. http://enviro.nfesc.navy.mil/erb/erb_a/restoration/ir_manual/Default.htm.

Earth Tech, Inc (Earth Tech). 2000. *Technical Memorandum, Evaluation of Radionuclides in Groundwater, Marine Corps Air Station, El Toro, California. Draft*. Honolulu, HI. March.

———. 2001. *Technical Memorandum, Phase II Evaluation of Radionuclides in Groundwater at Former Landfill Sites and the EOD Range, Marine Corps Air Station, El Toro, California*. Honolulu, HI. December.

———. 2003. *Final Environmental Baseline Survey, Former Marine Corps Air Station, El Toro, California*. San Diego, CA: NFECSW SDIEGO. September.

———. 2004a. *Final Finding of Suitability to Transfer (Parcels IV and Portions of Parcels I, II, and III), Former Marine Corps Air Station, El Toro, California*. San Diego, CA: NFECSW SDIEGO. July.

———. 2004b. *Final Finding of Suitability to Lease For Carve-outs within Parcels I, II, and II), Former Marine Corps Air Station, El Toro, California*. San Diego, CA: NFECSW SDIEGO. July.

Environmental Protection Agency, United States (EPA). 1988. *Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA, Interim Final*. Washington, DC: OSWER Directive 9355.3-01. EPA 540-G-89-004. October.

———. 1996. *Technology Screening Guide for Radioactively Contaminated Sites*. Washington, DC: Office of Air and Radiation; Office of Solid Waste and Emergency Response. EPA 402-R-96-017. November.

———. 1998. *EPA Memorandum: Use of Soil Cleanup Criteria in 40 CFR Part 192 as Remediation Goals for CERCLA Sites*. Washington, DC: Stephen D. Luftig, Office of Superfund Remediation

Technology Innovation; Larry Weinstock, Office of Radiation and Indoor Air Directive no. 9200.4-25. February 12.

———. 2002. EPA Facts about Radium. http://www.epa gov/superfund/resources/radiation/pdf /radium.pdf. July.

Environmental Protection Agency, United States, Region IX (EPA Region IX). 2000. *Region IX Preliminary Remediation Goal (PRG) Tables*. November. San Francisco.

Jacobs Engineering Group, Inc. (JEG). 1993. *Marine Corps Air Station El Toro: Installation Restoration Program Phase I Remedial Investigation Draft Technical Memorandum*.

Naval Facilities Engineering Command (NAVFAC). 1993. *Marine Corps Air Station El Toro: Installation Restoration Program Phase I Remedial Investigation Draft Technical Memorandum*

———. 2004. Draft Final Technical Report, Guidance for Optimizing Remedy Evaluation, Selection, and Design. Port Hueneme, CA. Battelle Memorial Institute. April.

OHM/IT Group. 1999. *Analytical and Location Survey Data Package, IRP Sites 8, 11, and 12*. Irvine, CA: NAVFAC EFD SOUTHWEST. May.

Roy F. Weston (Weston). 2000. *MCAS El Toro Final Historical Radiological Assessment*. May.

———. 2001. *MCAS El Toro Radiological Survey Plan*. January.

———. 2003. *Draft Radiological Sampling Amendment to Marine Corps Air Station El Toro Radiological Survey Plan*. October.

———. 2004a. *Draft Radiological Release Report, IRP Site 8 – (Units 2, 3, & 5), IRP Site 12, and IRP Site 25 (Bee Canyon Wash Outfall), Former Marine Corps Air Station (MCAS) El Toro, CA*. Vallejo, CA. July.

———. 2004b. *Radiological Data Package for Site 8, Units 1 and 4, Former Marine Corps Air Station (MCAS) El Toro, CA*. Vallejo, CA. Provided to Earth Tech in August 03.

Appendix A
Radiological Investigation Results Summary – IRP Site 8, Units 1 and 4

CONTENTS

ATTACHMENTS

FIGURES

TABLES

ACRONYMS AND ABBREVIATIONS

ALARA	as low as reasonably achievable
BCT	BRAC Cleanup Team
BRAC	Base Realignment and Closure
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
cpm	counts per minute
DandD	Decommissioning and Decontamination
DCGL	derived concentration guideline level
$DCGL_W$	DCGL for average concentrations over a wide area, used with statistical tests
DHS	Department of Health Services, California
DRMO	Defense Reutilization and Marketing Office
GPS	global positioning system
HRA	Historical Radiological Assessment
IL	investigation level
IL_{DHS}	IL proposed by the DHS
IL_{MDA}	IL based on the scan MDA
IRP	Installation Restoration Program
JEG	Jacobs Engineering Group, Inc.
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual
MCAS	Marine Corps Air Station
MDA	minimum detectable activities
MDC	minimum detectable concentration
MDCR	minimum detectable count rate
mrem	millirem
mrem/y	millirem per year
NaI	sodium iodide
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NIST	National Institute of Standards and Technology
NRC	Nuclear Regulatory Commission, United States
PCB	polychlorinated biphenyl
pCi/g	picoCurie per gram
PRG	preliminary remediation goal
Ra-226	radium-226
TEDE	total effective dose equivalent
U.S. EPA	United States Environmental Protection Agency

1. INTRODUCTION

This appendix presents methodology, procedures and evaluation of results for radiological investigations conducted at Units 1 and 4 of the Installation Restoration Program (IRP) Site 8 at the former Marine Corps Air Station (MCAS) El Toro, California. The radiological investigations included historical radiological assessment (HRA), scoping and characterization surveys, and soil sampling to assess the nature and extent of radiological contamination. This appendix also presents the results of screening-level risk and dose assessments conducted to quantify adverse human health effects associated with exposure to radioactive contaminants at Units 1 and 4 of Site 8. These assessments were based on the results of previous radiological investigations.

1.1 SITE LOCATION

Former MCAS El Toro is located in south-central Orange County, California, approximately 8 miles southeast of Santa Ana and 12 miles northeast of Laguna Beach (Figure A-1). Former MCAS El Toro covers approximately 4,738 acres and was closed on 2 July 1999, as a part of the Base Realignment and Closure (BRAC) Act.

Site 8 is located in the southwest quadrant of former MCAS El Toro, and is bounded by South Marine Way to the northeast, Q Street to the northwest, Building 360 to the southwest, and Building 800 to the southeast (Figure A-1 and Figure A-2).

1.2 SITE DESCRIPTION

Site 8 was formerly a Defense Reutilization and Marketing Office (DRMO) storage area for containerized liquids, and scrap and salvage materials from former MCAS El Toro and former MCAS Tustin. The scrap materials included mechanical and electrical components and various types of liquids.

Site 8 comprises two distinct but adjacent areas bisected by R Street: an old salvage yard and a main storage yard. These two areas are subdivided into the following five separate units:

- Unit 1, East Storage Yard
- Unit 2, West Storage Yard
- Unit 3, Refuse Pile Area (the location of a former refuse pile within the West Storage Yard)
- Unit 4, Polychlorinated biphenyl (PCB) Spill Area (located within the east storage yard)
- Unit 5, Old Salvage Yard (JEG 1993)

Units 1 and 4 constitute an area approximately 265 feet by 230 feet (61,000 square feet). Approximately, 90 percent of this area (54,900 square feet) consists of an unpaved, rocky soil surface, and the remaining 10 percent (6,100 square feet) consists of an asphalt-paved surface (see Figure A-2).

Radium-226 (Ra-226) is the primary radionuclide of potential concern at Site 8. Servicemen at former MCAS El Toro performed maintenance on aircraft that were equipped with components containing Ra-226. The radium containing components used on aircraft in 1940s, 50s, and 60s included radioluminescent dials, gauges, and markers. Equipment and consumer products such as electron tubes (historically containing cobalt-57, cobalt-60, thorium-232, krypton-85, etc.), smoke detectors (Americium-241), exit signs (Hydrogen-3), which contain exempt quantities of radioactive materials, may have also existed. Contamination, as a possible result of their use, would typically

only produce contamination at a small fraction of the release limit. Therefore, these radionuclides are not of concern (Weston 2004a).

1.3 PREVIOUS RADIOLOGICAL INVESTIGATIONS

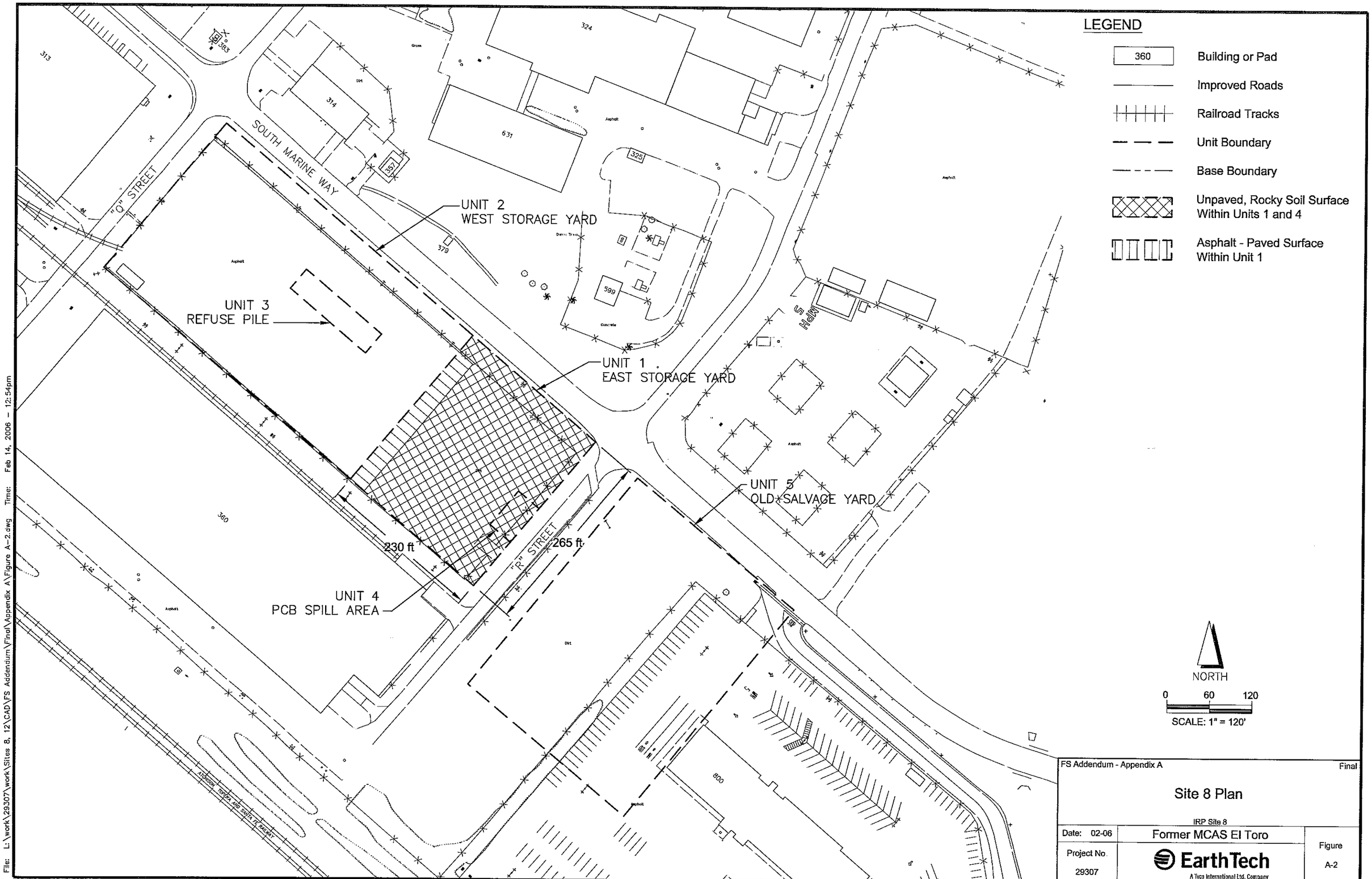
The radiological evaluation at Site 8 began with the stationwide HRA conducted for MCAS El Toro in 1999 and 2000 (Weston 2000). The purpose of the HRA was to identify potential, likely, or known sources of radioactive material and radioactive contamination based on existing or derived information and to identify sites that need further action as opposed to those posing no threat to human health. As a part of HRA, interviews, records review, site inspections, and limited informal surveys were conducted at MCAS El Toro. Based on the survey results, Site 8 was recommended for further investigation, including radiological surveys, since it potentially handled small quantities of Ra-226 painted parts and gauges. Subsequent to the issuance of the HRA, on-site radiological characterization surveys and sampling were conducted at Site 8 in June – November 2001 and March 2004. These investigations were performed in accordance with Radiological Survey Plan (Weston 2001) and Radiological Sampling Amendment (Weston 2003) at all the five units of IRP Site 8.

An analysis of data obtained from radiological surveys and soil sampling at Site 8 indicated that the site could be divided into two parts based on the level of Ra-226 contamination. The Ra-226 concentrations at Units 2, 3, and 5 of Site 8 were found to be consistent with the background, whereas locations with higher than background concentrations of Ra-226 were found at Units 1 and 4 of the site. Therefore, a radiological release report for Units 2, 3, and 5 of Site 8 was issued in conjunction with IRP Site 12, and IRP Site 25 (Bee Canyon Wash Outfall) (Weston 2004a). Based on the statistical analyses of the Ra-226 data, and risk and dose assessments, this report concluded that the occurrence and distribution of Ra-226 at Units 2, 3, and 5 of Site 8 are consistent with ambient concentrations. Therefore a Site Evaluation Accomplished (SEA) recommendation was made for Units 2, 3, and 5 of Site 8. The SEA recommendation denotes that the CERCLA requirement for the site evaluation of radionuclides has been accomplished, and radionuclides will be removed from the list of COPCs and further consideration under CERCLA at these units. However, since locations with higher than background concentrations of Ra-226 were found at Units 1 and 4 of Site 8, these units are addressed separately in this Action Memorandum.

1.4 ESTABLISHMENT OF RELEASE CRITERIA FOR RA-226

In order to evaluate whether a release of Ra-226 has occurred at Site 8, release criteria was established during the issuance of radiological release report for IRP Sites 8 (Units 2, 3, and 5), 12, and 25 (Weston 2004a). These criteria, based on regulatory agency guidelines, and United States (U.S.) Nuclear Regulatory Commission (NRC) and U.S. Environmental Protection Agency (EPA) regulations, included the following:

- *Radionuclide Concentration* – The site release level as defined in Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM) (EPA 2000) is known as derived concentration guideline level (DCGL). The Navy established a Ra-226 DCGL of 1 picoCurie per gram (pCi/g) above background. This level was established as the result of discussions with the EPA and California Department of Health Services (DHS) during the joint MCAS El Toro-Tustin Base Cleanup Team (BCT) Meeting of February 6, 2003. The risk and dose modeling conducted in support of this FS Addendum demonstrated that a Ra-226 concentration of 1 pCi/g above background satisfies the NRC dose criteria of 25 millirem per year (mrem/y) and results in a risk within the acceptable NCP risk range of 10^{-6} to 10^{-4}, for residential (unrestricted release) scenario. Additionally, the cost-benefit analysis shows that this concentration of Ra-226 is as low as reasonably achievable (ALARA) (see Appendix B for details).



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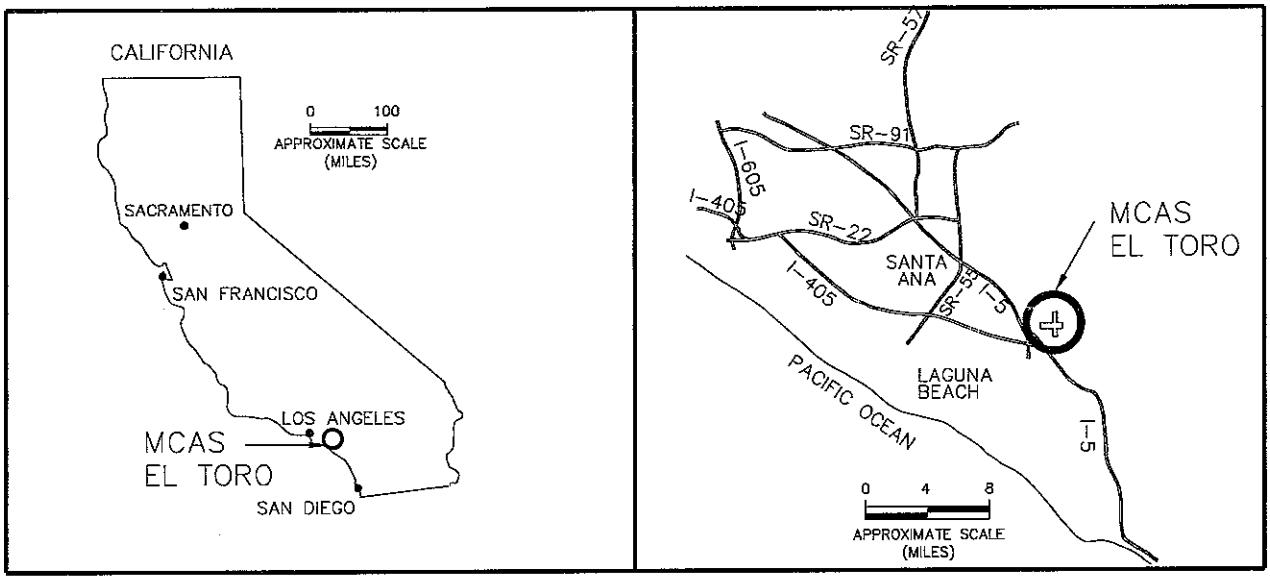
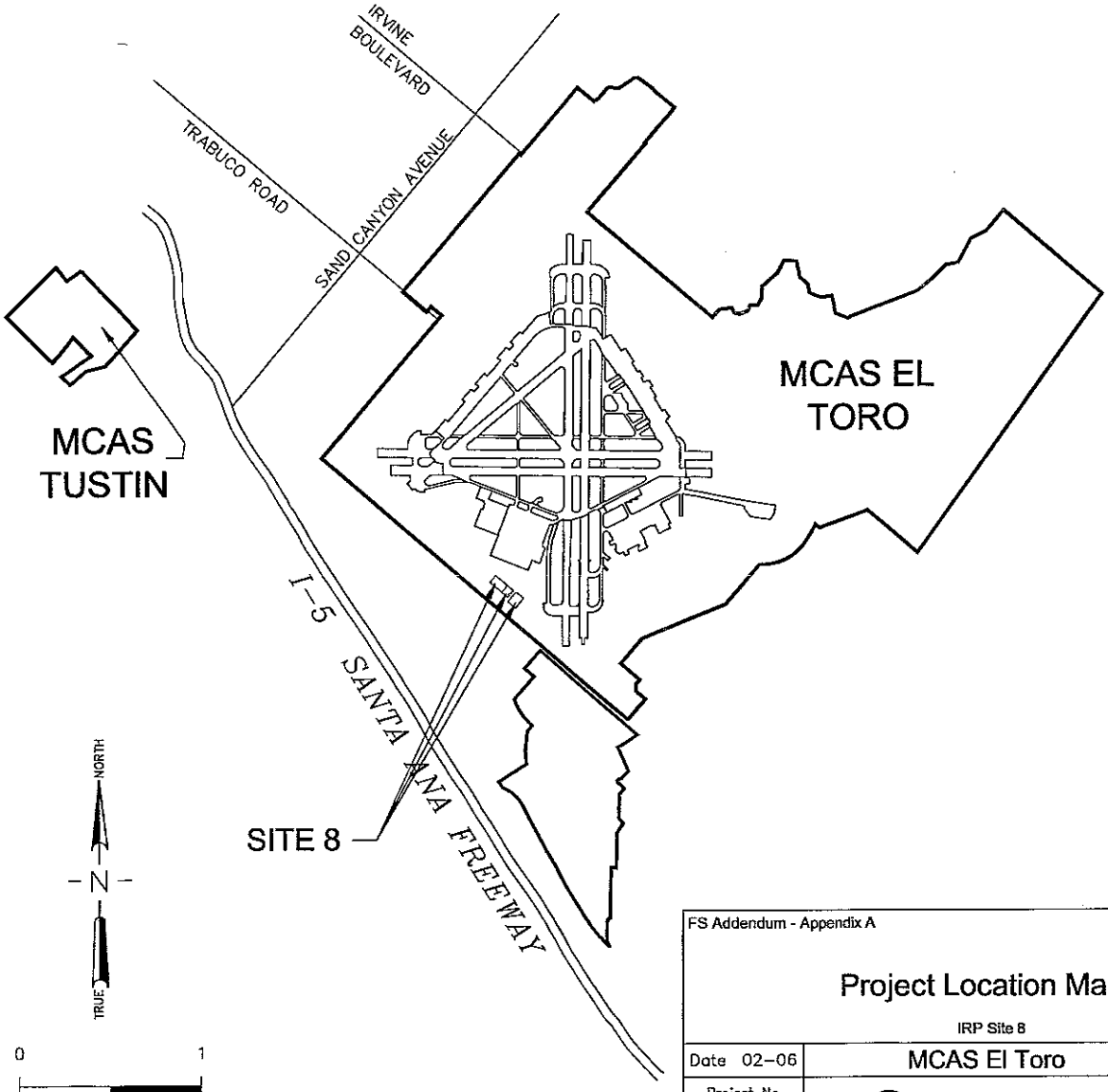
Site 8 Plan

IRP Site 8

Date: 02-06	Former MCAS El Toro	Figure A-2
Project No. 29307	EarthTech, A Tyco International Ltd. Company	





FS Addendum - Appendix A		Final
Project Location Map IRP Site 8		
Date 02-06	MCAS El Toro	Figure
Project No. 29307	EarthTech A Tyco International Ltd. Company	A-1

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Radiological analyses performed on 15 background reference area soil samples collected throughout the MCAS El Toro, yielded a mean background soil concentration for Ra-226 of 1.05 pCi/g. Using a DCGL of 1 pCi/g, the Ra-226 release limit for the Station was set at 2.05 pCi/g (1 pCi/g plus Station background).

- *Dose* – Residual radioactivity (due to Ra-226) that is distinguishable from background radiation results in a total effective dose equivalent (TEDE) to an average residential receptor that does not exceed 25 mrem/y, as specified in 10 Code of Federal Regulations (C.F.R.) 20, Subpart E, and that the residual radioactivity has been reduced to levels that are as low as reasonably achievable (ALARA) (10 C.F.R. Section 20.1402).
- *Risk* – Residual Ra-226 corresponds to the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) defined risk range of 10^{-6} to 10^{-4} and consideration of uncertainties including inherent spatial and measurement variabilities in Ra-226 concentrations, and uncertainties in risk assessment indicates that the level of Ra-226 exposure at the sites is in the range of background for a residential receptor.

The radiological surveys at IRP Site 8 were designed considering the DCGL for Ra-226 of 1 pCi/g above the mean value of the background measurements. This DCGL was also used for statistical evaluation of the radiological investigation data to assess if a release of Ra-226 had occurred.

Therefore, 16 samples were collected from higher reading areas in contiguous, homogeneous locations that were representative (see Section 2.1.2 - Note) of the several areas in question. Figure A-5 provides a survey map showing all 16 solid sample locations. Direct survey radiation measurements, using an unshielded 2 inch X 2 inch detector, were recorded at each sample location both before and after sampling (see Table A-4).

The samples collected from the site were individually packaged and sent, using chain-of-custody control, to a certified laboratory for isotopic analysis.

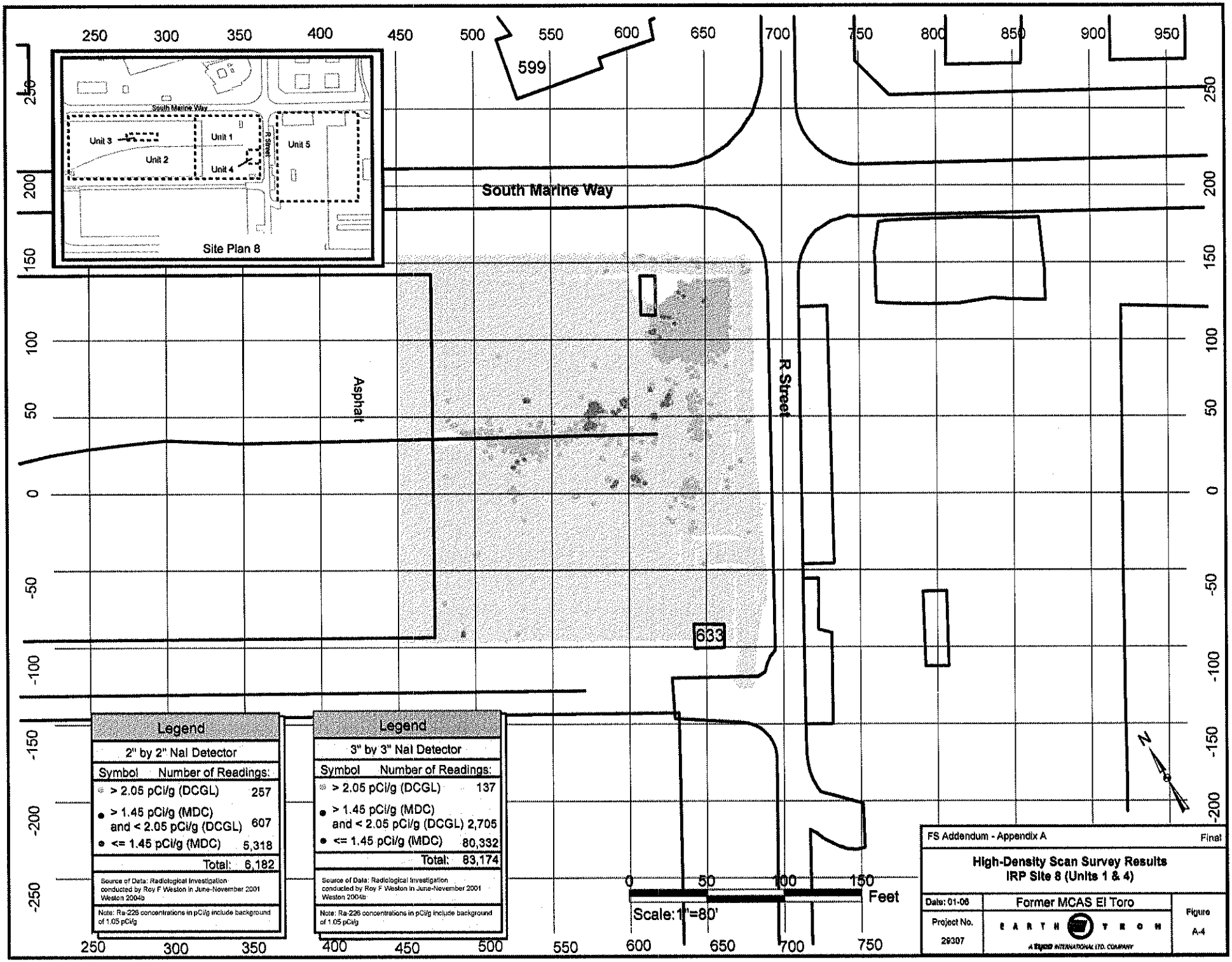
Of the 16 soil samples collected, 15 samples contained Ra-226 concentrations greater than 1 pCi/g above background. The concentrations of Ra-226 in these samples ranged from 7.5 to 329 pCi/g, and averaged at 95.98 pCi/g.

During sampling of Units 1 and 4, eight radiological anomalies were removed. The removed items comprised three sheet-metal label tags, one small screw, two pieces of asphalt, and three scoops of soil/rock (see Table A-5).

Table A-4: Soil Sampling Results

Sample No.[a]	Reading Before[b] (cpm)	Reading After[c] (cpm)	On Contact[d] (cpm)	Gamma Spectrometry Results[e]	
				Ra-226 (pCi/g)	Estimated Error (pCi/g)
2	28,631	23,002	8,951	8.90	1.6
3	51,632	36,995	15,183	16.10	2.7
4	132,007	30,317	24,165	63.00	11
5	65,726	43,631	15,990	45.40	7.7
6	78,007	49,196	29,693	329.00	54
7	91,152	30,777	21,441	76.00	13
8	16,088	16,109	15,639	7.50	1.4
9	39,999	34,980	16,667	49.20	8.2
10	131,637	61,373	35,742	256.00	42
11	97,300	35,936	13,233	19.80	3.4
12	107,152	45,628	37,845	307.00	51
13	32,942	23,590	13,437	15.70	2.7
14	20,214	16,762	14,403	19.10	3.2
15	10,499	10,416	12,127	0.95	0.29
16	406,605	235,204	33,776	239.00	40
17	57,700	36,846	21,985	83.00	14
Average	**85,456**	**45,673**	**20,642**	**95.98**	

Notes:
pCi/g picocuries per gram
<MDC less than minimum detectable concentration
[a] See Figure A-5 for sampling locations.
[b] Highest one-minute gamma reading observed on ground surface prior to collecting sample using 2x2 NaI detector.
[c] Highest one-minute gamma reading observed on ground surface after sample has been collected using 2x2 NaI detector.
[d] On-contact one-minute reading taken on outside of sample container using 2x2 NaI detector.
[e] See Section 1.2 for rationale on selection of Ra-226 as the isotope of concern.


Site Plan 8
South Marine Way
Unit 1
Unit 2
Unit 3
Unit 4
Unit 5
R Street
South Marine Way
Asphalt
R Street
599
633
Legend
2" by 2" NaI Detector
Symbol Number of Readings:
> 2.05 pCi/g (DCGL) 257
> 1.45 pCi/g (MDC) and < 2.05 pCi/g (DCGL) 607
<= 1.45 pCi/g (MDC) 5,318
Total: 6,182
Source of Data: Radiological Investigation conducted by Roy F Weston in June-November 2001 Weston 2004b
Note: Ra-226 concentrations in pCi/g include background of 1.05 pCi/g
Legend
3" by 3" NaI Detector
Symbol Number of Readings:
> 2.05 pCi/g (DCGL) 137
> 1.45 pCi/g (MDC) and < 2.05 pCi/g (DCGL) 2,705
<= 1.45 pCi/g (MDC) 80,332
Total: 83,174
Source of Data: Radiological Investigation conducted by Roy F Weston in June-November 2001 Weston 2004b
Note: Ra-226 concentrations in pCi/g include background of 1.05 pCi/g
0 50 100 150 Feet
Scale: 1"=80'
N
FS Addendum - Appendix A
Final
High-Density Scan Survey Results
IRP Site 8 (Units 1 & 4)
Date: 01-06
Former MCAS El Toro
Project No. 29307
EARTH TECH
A TETRA TECH INTERNATIONAL LTD. COMPANY
Figure A-4

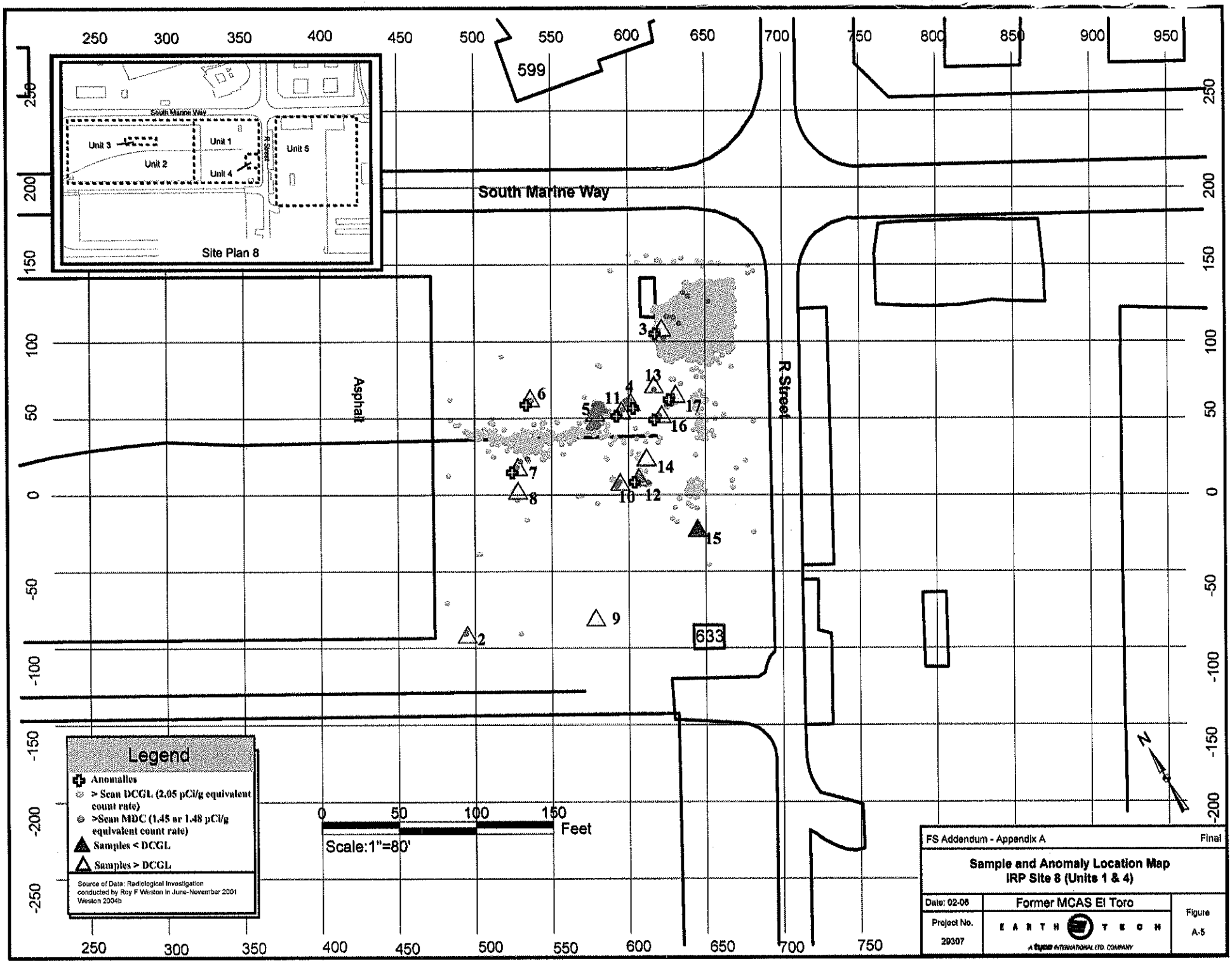

South Marine Way
Unit 3
Unit 1
Unit 2
Unit 4
R Street
Unit 5
Site Plan 8
South Marine Way
Asphalt
R Street
599
633
Legend
Anomalies
> Scan DCGL (2.05 pCi/g equivalent count rate)
>Scan MDC (1.45 or 1.48 pCi/g equivalent count rate)
Samples < DCGL
Samples > DCGL
Source of Data: Radiological Investigation conducted by Roy F Weston in June-November 2001 Weston 2004b
0 50 100 150 Feet
Scale:1"=80'
N
FS Addendum - Appendix A
Final
Sample and Anomaly Location Map
IRP Site 8 (Units 1 & 4)
Date: 02-06
Former MCAS El Toro
Project No. 29307
EARTH TECH
A Tyco INTERNATIONAL LTD. COMPANY
Figure A-5

Table A-5: Anomalies Description

Anomaly[a] No.	Description	Anomaly On-Contact Reading[b] (cpm)
3	Chunk of asphalt	66,064
4	Small metal tag	109,199
6	Removed half a bag of rocks and dug to 6" depth; could not find any discrete sources	35 448
7	2 anomalies; one small screw and one scoop of dirt/rocks	140,736
11	Metal label plate 1/2" x 2"	188,972
12	One scoop of dirt with rocks	141,483
16	Chunk of asphalt; dug to 6"; could not find any discrete sources	83,121
17	Metal label plate 1/2" x 2"	62,249

Notes:
[a] See Figure A-5 for anomaly locations.
[b] On-contact one-minute reading taken on outside of anomaly container using 2x2 NaI detector.

3.3 TEDE Analysis Results

Based on the average concentration of Ra-226 in the soil samples collected from Units 1 and 4 of Site 8, TEDE analysis was performed for a residential receptor using the NRC dose assessment software, DandD version 2.1.0. The average concentration of Ra-226 at Units 1 and 4 of Site 8 was estimated to be 95.98 pCi/g. For an incremental soil concentration of 94.93 pCi/g (95.98 pCi/g minus 1.05 pCi/g), the DandD software yielded a TEDE of 3,800 mrem/y. The 95 percent confidence interval for the 0.9 quantile value of the TEDE results in a range from 3,660 to 4,100 mrem/y. Attachment 1 presents a detailed report on TEDE analysis for residential scenario.

3.4 Risk Screening Results

Incremental risk above background was calculated for average incremental concentration of Ra-226 of 94.93 pCi/g, using U.S. EPA's PRG calculator for radionuclides (EPA 2004). This calculation estimated the risk due to incremental concentration of Ra-226 of approximately 7.7E-03, which is beyond the NCP defined risk range of 10^{-6} to 10^{-4} (see Attachment 2). Additionally, this risk exceeds the action level (10^{-4}) typically associated with remediation requirements.

4. SUMMARY AND CONCLUSIONS

The radiological investigations conducted at Units 1 and 4 of Site 8 including radiological scan surveys and soil sampling are sufficient to assess if the release of Ra-226 has occurred at these units in accordance with the release criteria specified in Section 1.4. The screening level risk and dose assessments conducted using the results of radiological investigations provide a reasonable evaluation of human health effects due to Ra-226.

4.1 SUMMARY

Following is the summary of results for radiological investigations conducted at Units 1 and 4 of Site 8:

- Of the total of 89,356 high density scan survey readings collected at Units 1 and 4 of Site 8, a total of 3,706 data points were observed to exceed the IL_{MDA} for the shielded 3 inch X 3 inch detectors or the unshielded 2 inch X 2 inch detector.
- A total of 394 data points were observed to exceed the approximate scan survey DCGL for the shielded 3 inch X 3 inch detectors or the unshielded 2 inch X 2 inch detector.
- Of the 16 soil samples collected from the areas with elevated scan readings (greater than IL), 15 samples contained Ra-226 concentrations greater than 1 pCi/g above background.
- The concentrations of Ra-226 in the soil samples that exceeded the Ra-226 DCGL (2.05 pCi/g) ranged from 7.5 to 329 pCi/g.
- The average Ra-226 concentration in the samples collected at Units 1 and 4 of Site 8 was 95.98 pCi/g.
- During soil sampling at Units 1 and 4, eight radiological anomalies were removed. The removed items comprised three sheet-metal label tags, one small screw, two pieces of asphalt, and three scoops of soil/rock.
- The results of dose assessment using DandD software indicated that an incremental Ra-226 concentration in soil of 94.93 pCi/g (95.98 pCi/g minus 1.05 pCi/g), results in a TEDE of approximately 3,800 mrem/y.
- The risk due to incremental concentration of Ra-226 above background, using U.S. EPA's PRG calculator was estimated to be 7.7E-03, which exceeds the action level (10^{-4}) typically associated with remediation requirements.

4.2 CONCLUSIONS

The scan survey and soil sampling results at Units 1 and 4 of Site 8 indicate that Ra-226 is present at concentrations above background at these units. The results of the TEDE analysis using incremental concentration of Ra-226 above background at Units 1 and 4 indicate that TEDE for the residential receptor exceeds 25 mrem/y. Additionally the incremental carcinogenic risk above background of 7.7E-03 exceeds the action level (10^{-4}) typically associated with remediation requirements. Thus both risk screening and dose assessment indicate that present levels of Ra-226 at Units 1 and 4 present unacceptable risk to human health, and therefore must be addressed by a response action under Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA).

5. REFERENCES

Environmental Protection Agency, United States (EPA). 2000. *Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM), Revision 1. NUREG-1575, Rev. 1, EPA/402/R-97/016 Rev. 1; DOE/EH-0624, Rev. 1.* August.

———. 2004 (accessed). *Preliminary Remediation Goals for Radionuclides.* http://epa-prgs.ornl.gov/radionuclides/. 10 August.

Jacobs Engineering Group, Inc. (JEG). 1993. *Marine Corps Air Station El Toro Installation Restoration Program Phase I Remedial Investigation Draft Technical Memorandum.*

Roy F. Weston (Weston). 2000. *MCAS El Toro Final Historical Radiological Assessment.* May.

———. 2001. *MCAS El Toro Radiological Survey Plan.* Vallejo, CA. January.

———. 2003. *Draft Radiological Sampling Amendment to Marine Corps Air Station El Toro Radiological Survey Plan.* Vallejo, CA. October.

———. 2004a. *Draft Radiological Release Report, IRP Site 8 – (Units 2, 3, & 5), IRP Site 12, and IRP Site 25 (Bee Canyon Wash Outfall), Former Marine Corps Air Station (MCAS) El Toro, CA.* Vallejo, CA. July.

———. 2004b. *Radiological Data Package for Site 8, Units 1 and 4, Former Marine Corps Air Station (MCAS) El Toro, CA.* Vallejo, CA. Provided to Earth Tech on August 03.

United States Nuclear Regulatory Commission (NRC). 1998. *Minimum Detectable Concentrations with Typical Radiation Survey Instruments for Various Contaminants and Field Conditions. NUREG 1507* Washington, DC. June.

Attachment A-1
Dose Assessment Summary for Existing Conditions – DandD Software Version 2.1.0

DandD Residential Scenario

DandD Version: 2.1.0
Run Date/Time: 8/10/2004 5:05:42 PM
Site Name: Site8 Units 1&4
Description: TEDE Analysis for Units 1 and 4 of Site 8 using average Ra-226 Concentration
FileName:L:\work\Remediation\Projects\29307 (CTO-68)\Sites 8, 12 \DOCUMENTS\Action_Memo\WorkingDraft\Appendix C\DandD_Units1&4Sim.mcd

Options:

Implicit progeny doses NOT included with explicit parent doses
Nuclide concentrations are NOT distributed among all progeny
Number of simulations: 100
Seed for Random Generation: 8718721
Averages used for behavioral type parameters

External Pathway is ON
Inhalation Pathway is ON
Secondary Ingestion Pathway is ON
Agricultural Pathway is ON
Drinking Water Pathway is ON
Irrigation Pathway is ON
Surface Water Pathway is ON

Initial Activities:

Nuclide	Area of Contamination (m^2)	Distribution
226Ra+C	UNLIMITED	CONSTANT(pCi/g)
Justification for concentration: Weston's soil sampling data for Ra-226		Value 9.49E+01

Chain Data:

Number of chains: **1**

Chain No. 1: **226Ra+C**
Nuclides in chain: **10**

Nuclide	Chain Position	Half Life	First Parent	Fractional Yield	Second Parent	Fractional Yield	Ingestion CEDE Factor (Sv/Bq)	Inhalation CEDE Factor (Sv/Bq)	Sur Dose Fa ((Sv/d)/
226Ra+C	1	5.84E+05							
222Rn	2	3.82E+00	1	1	0	0	0.00E+00	0.00E+00	3.41E-1
218Po	Implicit		2	1			0.00E+00	0.00E+00	7.67E-1
214Pb	Implicit		2	0.9998			1.69E-10	2.11E-09	2.10E-1
218At	Implicit		2	0.0002			0.00E+00	0.00E+00	0.00E+(
214Bi	Implicit		2	1			7.64E-11	1.78E-09	1.22E-1
214Po	Implicit		2	0.9998			0.00E+00	0.00E+00	7.02E-1
210Pb	3	8.15E+03	2	1	0	0	1.45E-06	3.67E-06	2.14E-1
210Bi	4	5.01E+00	3	1	0	0	1.73E-09	5.29E-08	9.06E-1
210Po	5	1.38E+02	4	1	0	0	5.14E-07	2.54E-06	7.16E-1

Initial Concentrations:

Note: All reported values are the upper bound of the symmetric 95% confidence interval for the 0.9 quantile value

Nuclide	Soil Concentration (pCi/g)
210Bi	9.63E+01
210Po	9.63E+01
226Ra	9.49E+01
222Rn	9.49E+01
218Po	9.49E+01
214Pb	9.49E+01
218At	1.90E-02
214Bi	9.49E+01
214Po	9.49E+01
210Pb	9.63E+01

Model Parameters:

General Parameters:

Parameter Name	Description	Distribution
Tv (1):Translocation:Leafy	Translocation factor for leafy vegetables	CONSTANT(none)
Default value used		Value 1.00E+00
Tv (2):Translocation:Root	Translocation factor for other vegetables	CONSTANT(none)
Default value used		Value 1.00E-01
Tv (3):Translocation:Fruit	Translocation factor for fruit	CONSTANT(none)
Default value used		Value 1.00E-01
Tv (4):Translocation:Grain	Translocation factor for grain	CONSTANT(none)
Default value used		Value 1.00E-01
Tf(1):Translocation:Beef Forage	Translocation factor for forage consumed by beef cattle	CONSTANT(none)
Default value used		Value 1.00E+00
Tf (2):Translocation:Poultry Forage	Translocation factor for forage consumed by poultry	CONSTANT(none)
Default value used		Value 1.00E+00
Tf(3):Translocation:Milk Cow	Translocatioin factor for forage consumed by milk cows	CONSTANT(none)
Default value used		Value 1.00E+00
Tf (4):Translocation:Layer Hen Forage	Translocation factor for forage consumed by layer hens	CONSTANT(none)
Default value used		Value 1.00E+00
Tg(1):Translocation:Beef Grain	Translocation factor for stored grain consumed by beef cattle	CONSTANT(none)
Default value used		Value 1.00E-01
Tg (2):Translocation:Poultry Grain	Translocation factor for stored grain consumed by poultry	CONSTANT(none)
Default value used		Value 1.00E-01
Tg (3):Translocation:Milk Cow Grain	Translocation factor for stored grain consumed by milk cows	CONSTANT(none)
Default value used		Value 1.00E-01

Tg (4):Translocation:Layer Hen Grain	Translocation factor for stored grain consumed by layer hens	CONSTANT (none)
Default value used		Value 1.00E-01
Th(1):Translocation:Beef Hay	Translocation factor for stored hay consumed by beef cattle	CONSTANT (none)
Default value used		Value 1.00E+00
Th (2):Translocation:Poultry Hay	Translocation factor for stored hay consumed by poultry	CONSTANT (none)
Default value used		Value 1.00E+00
Th (3):Translocation:Milk Cow Hay	Translocation factor for stored hay consumed by milk cows	CONSTANT (none)
Default value used		Value 1.00E+00
Th (4):Translocation:Layer Hen Hay	Translocation factor for stored hay consumed by layer hens	CONSTANT (none)
Default value used		Value 1.00E+00
fca(1):Beef Carbon Fraction	Mass fraction of beef cattle that is carbon	CONSTANT (none)
Default value used		Value 3.60E-01
fca(2):Poultry Carbon Fraction	Mass fraction of poultry that is carbon	CONSTANT (none)
Default value used		Value 1.80E-01
fca(3):Milk Carbon Fraction	Mass fraction of milk that is carbon	CONSTANT (none)
Default value used		Value 6.00E-02
fca(4):Eggs Carbon Fraction	Mass fraction of an egg that is carbon	CONSTANT (none)
Default value used		Value 1.60E-01
fcf(1):Beef Forage Carbon Fraction	Mass fraction of wet forage consumed by beef cattle that is carbon	CONSTANT (none)
Default value used		Value 1.10E-01
fcf(2):Poultry Forage Carbon Fraction	Mass fraction of wet forage consumed by poultry that is carbon	CONSTANT (none)
Default value used		Value 1.10E-01
fcf(3):Milk Cow Forage Carbon Fraction	Mass fraction of wet forage consumed by milk cows that is carbon	CONSTANT (none)
Default value used		Value 1.10E-01

fcf(4):Layer Hen Forage Carbon Fraction	Mass fraction of wet forage consumed by layer hens that is carbon	CONSTANT(none)
Default value used		Value 1.10E-01
fcg(1):Beef Grain Carbon Fraction	Mass fraction of wet stored grain consumed by beef cattle that is carbon	CONSTANT(none)
Default value used		Value 4.00E-01
fcg(2):Poultry Grain Carbon Fraction	Mass fraction of wet stored grain consumed by poultry that is carbon	CONSTANT(none)
Default value used		Value 4.00E-01
fcg(3):Milk Cow Grain Carbon Fraction	Mass fraction of wet stored grain consumed by milk cows that is carbon	CONSTANT(none)
Default value used		Value 4.00E-01
fcg(4):Layer Hen Grain Carbon Fraction	Mass fraction of wet stored grain consumed by layer hens that is carbon	CONSTANT(none)
Default value used		Value 4.00E-01
fch(1):Beef Hay Carbon Fraction	Mass fraction of wet stored hay consumed by beef cattle that is carbon	CONSTANT(none)
Default value used		Value 7.00E-02
fch(2):Poultry Hay Carbon Fraction	Mass fraction of wet stored hay consumed by poultry that is carbon	CONSTANT(none)
Default value used		Value 7.00E-02
fch(3):Milk Cow Hay Carbon Fraction	Mass fraction of wet stored hay consumed by milk cows that is carbon	CONSTANT(none)
Default value used		Value 7.00E-02
fch(4):Layer Hen Hay Carbon Fraction	Mass fraction of wet stored hay consumed by layer hens that is carbon	CONSTANT(none)
Default value used		Value 7.00E-02
fCd:Soil Carbon Fraction	Mass fraction of dry soil that is carbon	CONSTANT(none)
Default value used		Value 3.00E-02
SATac:Animal Product Specific Activity	Specific activity equivalence of animal product and specific activity of animal feed, forage, and soil	CONSTANT(none)
Default value used		Value 1.00E+00
xf(1):Beef Forage Contaminated Fraction	Fraction of forage consumed by beef cattle that is contaminated	CONSTANT(none)

Default value used		Value 1.00E+00
xf(2):Poultry Forage Contaminated Fraction	Fraction of forage consumed by poultry that is contaminated	CONSTANT(none)
Default value used		Value 1.00E+00
xf(3):Milk Cow Forage Contaminated Fraction	Fraction of forage consumed by milk cows that is contaminated	CONSTANT(none)
Default value used		Value 1.00E+00
xf(4):Layer Hen Forage Contaminated Fraction	Fraction of forage consumed by layer hens that is contaminated	CONSTANT(none)
Default value used		Value 1.00E+00
xg(1):Beef Grain Contaminated Fraction	Fraction of stored grain consumed by beef cattle that is contaminated	CONSTANT(none)
Default value used		Value 1.00E+00
xg(2):Poultry Grain Contaminated Fraction	Fraction of stored grain consumed by poultry that is contaminated	CONSTANT(none)
Default value used		Value 1.00E+00
xg(3):Milk Cow Grain Contaminated Fraction	Fraction of stored grain consumed by milk cows that is contaminated	CONSTANT(none)
Default value used		Value 1.00E+00
xg(4):Layer Hen Grain Contaminated Fraction	Fraction of stored grain that is consumed by layer hens that is contaminated	CONSTANT(none)
Default value used		Value 1.00E+00
xh(1):Beef Hay Contaminated Fraction	Fraction of stored hay consumed by beef cattle that is contaminated	CONSTANT(none)
Default value used		Value 1.00E+00
xh(2):Poultry Hay Contaminated Fraction	Fraction of stored hay consumed by poultry that is contaminated	CONSTANT(none)
Default value used		Value 1.00E+00
xh(3):Milk Cow Hay Contaminated Fraction	Fraction of stored hay consumed by milk cows that is contaminated	CONSTANT(none)
Default value used		Value 1.00E+00
xh(4):Layer Hen Hay Contaminated Fraction	Fraction of stored hay consumed by layer hens that is contaminated	CONSTANT(none)
Default value used		Value 1.00E+00
xw(1):Beef Water Contaminated Fraction	Fraction of water that is consumed by beef cattle that is contaminated	CONSTANT(none)

Default value used		Value 1.00E+00
xw(2):Poultry Water Contaminated Fraction	Fraction of water consumed by poultry that is contaminated	CONSTANT(none)
Default value used		Value 1.00E+00
xw(3):Milk Cow Water Contaminated Fraction	Fraction of water consumed by milk cows that is contaminated	CONSTANT(none)
Default value used		Value 1.00E+00
xw(4):Layer Hen Water Contaminated Fraction	Fraction of water consumed by layer hens that is contaminated	CONSTANT(none)
Default value used		Value 1.00E+00
DIET:Garden Diet	Fraction of human diet grown onsite	CONSTANT(none)
Default value used		Value 1.00E+00
Uv(1):Diet - Leafy	Yearly human consumption of leafy vegetables	CONSTANT(kg/y)
Default value used		Value 2.14E+01
Uv(2):Diet - Roots	Yearly human consumption of other vegetables	CONSTANT(kg/y)
Default value used		Value 4.46E+01
Uv(3):Diet - Fruit	Yearly human consumption of fruits	CONSTANT(kg/y)
Default value used		Value 5.28E+01
Uv(4):Diet - Grain	Yearly human consumption of grains	CONSTANT(kg/y)
Default value used		Value 1.44E+01
Ua(1):Diet - Beef	Yearly human consumption of beef	CONSTANT(kg/y)
Default value used		Value 3.98E+01
Ua(2):Diet - Poultry	Yearly human consumption of poultry	CONSTANT(kg/y)
Default value used		Value 2.53E+01
Ua(3):Diet - Milk	Yearly human consumption of milk	CONSTANT(L/y)
Default value used		Value 2.33E+02
Ua(4):Diet - Egg	Yearly human consumption of eggs	CONSTANT(kg/y)
Default value used		Value 1.91E+01
Uf:Diet - Fish	Yearly human consumption of fish produced from an onsite pond	CONSTANT(kg/y)
Default value used		Value 2.06E+01
tf:Consumption Period	Consumption period for fish	CONSTANT(days)

Default value used		Value 3.65E+02
tcv(1):Consumption Period - Leafy	Food consumption period for leafy vegetables	CONSTANT(days)
Default value used		Value 3.65E+02
tcv(2):Consumption Period - Roots	Food consumption period for other vegetables	CONSTANT(days)
Default value used		Value 3.65E+02
tcv(3):Consumption Period - Fruit	Food consumption period for fruits	CONSTANT(days)
Default value used		Value 3.65E+02
tcv(4):Consumption Period - Grain	Food consumption period for grains	CONSTANT(days)
Default value used		Value 3.65E+02
tca(1):Consumption Period - Beef	Food consumption period for beef	CONSTANT(days)
Default value used		Value 3.65E+02
tca(2):Consumption Period - Poultry	Food consumption period for poultry	CONSTANT(days)
Default value used		Value 3.65E+02
tca(3):Consumption Period - Milk	Food consumption period for milk	CONSTANT(days)
Default value used		Value 3.65E+02
tca(4):Consumption Period - Egg	Food consumption period for eggs	CONSTANT(days)
Default value used		Value 3.65E+02
Nunsat:Number of Unsaturated Layers	Number of model layers used to represent the unsaturated zone	CONSTANT(none)
Default value used		Value 1.00E+01
TstartR:Start Time	The start time of the scenario in days	CONSTANT(days)
Default value used		Value 0.00E+00
TendR:End Time	The ending time of the scenario in days	CONSTANT(days)
Default value used		Value 3.65E+05
dtR:Time Step Size	The time step size	CONSTANT(days)
Default value used		Value 3.65E+02
PstepR:Print Step Size	The time steps for the history file. Doses will be written to the history file every n time steps	CONSTANT(none)
Default value used		Value 1.00E+00

TI:Indoor Exposure Period	The time the resident spends indoors	CONSTANT(days/year)
Default value used		Value 2.40E+02
TX:Outdoor Exposure Period	The time the resident spends outdoors	CONSTANT(days/year)
Default value used		Value 4.02E+01
TG:Gardening Period	The time the resident spends gardening	CONSTANT(days/year)
Default value used		Value 2.92E+00
TTR:Total time in period	Total time in the one year exposure period	CONSTANT(days/year)
Default value used		Value 3.65E+02
SFI:Indoor Shielding Factor	Shielding factor for the residence	CONSTANT(none)
Default value used		Value 5.52E-01
SFO:Outdoor Shielding Factor	Shielding factor for the cover soil	CONSTANT(none)
Default value used		Value 1.00E+00
PD:Floor dust loading	Floor dust loading	UNIFORM(g/m**2)
Default value used		Lower Limit 2.00E-02 Upper Limit 3.00E-01
RFR:Indoor Resuspension Factor	Resuspension factor for indoor dust	LOGUNIFORM(1/m)
Default value used		Lower Limit 1.00E-07 Upper Limit 8.00E-05
CDO:Outdoor Dust Loading	Average dust loading outdoors	LOGUNIFORM(g/m**3)
Default value used		Lower Limit 1.00E-07 Upper Limit 1.00E-04
CDI:Indoor Dust Loading	Average dust loading indoors	DERIVED(g/m**3)
Default value used		
PF:Indoor/Outdoor Penetration Factor	Fraction of outdoor dust in indoor air	UNIFORM(none)
Default value used		Lower Limit 2.00E-01 Upper Limit 7.00E-01
CDG:Gardening Dust Loading	Average dust loading while gardening	UNIFORM(g/m**3)
Default value used		Lower Limit 1.00E-04 Upper Limit 7.00E-04
VR:Indoor Breathing Rate	Breathing rate while indoors	CONSTANT(m**3/hr)

Default value used		Value 9.00E-01
VX:Outdoor Breathing Rate	Breathing rate while outdoors	CONSTANT(m**3/hr)
Default value used		Value 1.40E+00
VG:Gardening Breathing Rate	Breathing rate while gardening	CONSTANT(m**3/hr)
Default value used		Value 1.70E+00
GR:Soil Ingestion Transfer Rate	Average rate of soil ingestion	CONSTANT(g/d)
Default value used		Value 5.00E-02
UW:Diet - Water	Drinking water ingestion rate	CONSTANT(L/d)
Default value used		Value 1.26E+00
H1:Surface Soil Thickness	Thickness of the surface soil layer	CONSTANT(m)
Default value used		Value 1.50E-01
H2:Unsaturated Zone Thickness	Thickness of the unsaturated zone	CONTINUOUS LINEAR(m)

Default value used

Value	Probability
3.05E-01	0.00E+00
6.68E-01	4.76E-03
8.11E-01	9.52E-03
9.21E-01	1.43E-02
9.94E-01	1.91E-02
1.03E+00	2.38E-02
1.07E+00	2.86E-02
1.14E+00	3.33E-02
1.21E+00	3.81E-02
1.30E+00	4.29E-02
1.31E+00	4.76E-02
1.32E+00	5.24E-02
1.56E+00	5.71E-02
1.58E+00	6.19E-02
1.61E+00	6.67E-02
1.69E+00	7.62E-02
1.78E+00	8.57E-02
1.80E+00	9.05E-02
1.81E+00	9.52E-02
1.84E+00	1.00E-01
1.87E+00	1.05E-01
1.92E+00	1.10E-01
2.04E+00	1.14E-01
2.10E+00	1.19E-01
2.11E+00	1.24E-01
2.32E+00	1.29E-01
2.36E+00	1.33E-01
2.37E+00	1.38E-01
2.39E+00	1.43E-01

2.44E+00	1.48E-01
2.44E+00	1.52E-01
2.45E+00	1.57E-01
2.59E+00	1.62E-01
2.63E+00	1.67E-01
2.69E+00	1.71E-01
2.79E+00	1.76E-01
2.81E+00	1.81E-01
2.90E+00	1.86E-01
2.95E+00	1.91E-01
3.07E+00	1.95E-01
3.18E+00	2.00E-01
3.22E+00	2.05E-01
3.30E+00	2.10E-01
3.34E+00	2.14E-01
3.37E+00	2.19E-01
3.44E+00	2.24E-01
3.58E+00	2.29E-01
3.62E+00	2.33E-01
3.66E+00	2.38E-01
3.74E+00	2.43E-01
3.86E+00	2.48E-01
3.88E+00	2.52E-01
4.17E+00	2.57E-01
4.26E+00	2.62E-01
4.44E+00	2.71E-01
4.63E+00	2.76E-01
4.87E+00	2.81E-01
5.13E+00	2.86E-01
5.18E+00	2.91E-01
5.54E+00	2.95E-01
5.83E+00	3.00E-01
5.86E+00	3.05E-01
5.86E+00	3.10E-01
5.90E+00	3.14E-01
6.06E+00	3.19E-01
6.13E+00	3.24E-01
6.17E+00	3.29E-01
6.22E+00	3.33E-01
6.31E+00	3.38E-01
6.36E+00	3.43E-01
6.40E+00	3.48E-01
6.46E+00	3.52E-01
6.51E+00	3.57E-01
6.55E+00	3.62E-01
6.60E+00	3.67E-01
6.86E+00	3.71E-01
6.93E+00	3.76E-01
6.95E+00	3.86E-01
6.97E+00	3.91E-01
7.09E+00	3.95E-01
7.18E+00	4.00E-01
7.35E+00	4.05E-01
7.36E+00	4.10E-01

7.40E+00	4.14E-01
7.43E+00	4.19E-01
7.46E+00	4.24E-01
7.59E+00	4.29E-01
7.60E+00	4.33E-01
7.64E+00	4.38E-01
7.87E+00	4.43E-01
8.10E+00	4.48E-01
8.28E+00	4.52E-01
8.35E+00	4.57E-01
8.71E+00	4.62E-01
8.71E+00	4.67E-01
8.73E+00	4.71E-01
8.79E+00	4.76E-01
8.80E+00	4.81E-01
8.82E+00	4.86E-01
8.85E+00	4.91E-01
8.89E+00	4.95E-01
8.90E+00	5.00E-01
8.99E+00	5.05E-01
9.00E+00	5.10E-01
9.13E+00	5.14E-01
9.14E+00	5.19E-01
9.21E+00	5.24E-01
9.31E+00	5.29E-01
9.55E+00	5.33E-01
9.60E+00	5.38E-01
9.63E+00	5.43E-01
9.86E+00	5.48E-01
1.05E+01	5.52E-01
1.07E+01	5.57E-01
1.13E+01	5.62E-01
1.15E+01	5.67E-01
1.17E+01	5.71E-01
1.20E+01	5.76E-01
1.26E+01	5.81E-01
1.26E+01	5.86E-01
1.28E+01	5.91E-01
1.32E+01	5.95E-01
1.32E+01	6.00E-01
1.34E+01	6.05E-01
1.34E+01	6.10E-01
1.36E+01	6.14E-01
1.37E+01	6.19E-01
1.38E+01	6.24E-01
1.41E+01	6.29E-01
1.45E+01	6.33E-01
1.51E+01	6.38E-01
1.52E+01	6.43E-01
1.61E+01	6.48E-01
1.62E+01	6.52E-01
1.65E+01	6.57E-01
1.66E+01	6.62E-01

1.69E+01	6.67E-01
1.74E+01	6.71E-01
1.82E+01	6.76E-01
1.84E+01	6.81E-01
1.84E+01	6.86E-01
1.87E+01	6.91E-01
1.95E+01	6.95E-01
2.01E+01	7.00E-01
2.07E+01	7.05E-01
2.08E+01	7.10E-01
2.17E+01	7.14E-01
2.24E+01	7.19E-01
2.27E+01	7.24E-01
2.29E+01	7.29E-01
2.29E+01	7.33E-01
2.40E+01	7.38E-01
2.47E+01	7.43E-01
2.60E+01	7.48E-01
2.65E+01	7.52E-01
2.72E+01	7.57E-01
2.73E+01	7.62E-01
2.76E+01	7.67E-01
2.77E+01	7.71E-01
2.78E+01	7.76E-01
2.80E+01	7.81E-01
2.86E+01	7.86E-01
2.94E+01	7.91E-01
3.01E+01	7.95E-01
3.03E+01	8.00E-01
3.06E+01	8.10E-01
3.08E+01	8.14E-01
3.11E+01	8.19E-01
3.17E+01	8.24E-01
3.17E+01	8.29E-01
3.17E+01	8.33E-01
3.22E+01	8.38E-01
3.39E+01	8.43E-01
3.48E+01	8.48E-01
3.54E+01	8.52E-01
3.60E+01	8.57E-01
3.68E+01	8.62E-01
4.03E+01	8.67E-01
4.07E+01	8.71E-01
4.24E+01	8.76E-01
4.29E+01	8.81E-01
4.42E+01	8.86E-01
4.72E+01	8.91E-01
4.97E+01	8.95E-01
5.12E+01	9.00E-01
6.13E+01	9.05E-01
6.19E+01	9.10E-01
6.23E+01	9.14E-01
6.32E+01	9.19E-01

		6.59E+01 9.24E-01 6.73E+01 9.29E-01 7.47E+01 9.33E-01 7.92E+01 9.38E-01 8.12E+01 9.43E-01 8.28E+01 9.48E-01 8.47E+01 9.52E-01 8.96E+01 9.57E-01 9.47E+01 9.62E-01 1.08E+02 9.67E-01 1.13E+02 9.71E-01 1.15E+02 9.76E-01 1.42E+02 9.81E-01 1.77E+02 9.86E-01 1.78E+02 9.91E-01 1.80E+02 9.95E-01 3.16E+02 1.00E+00
N1:Surface Soil Porosity	Porosity of the surface soil layer	DERIVED(none)
Default value used		
N2:Unsaturated Zone Porosity	Porosity of the unsaturated zone	DERIVED(none)
Default value used		
F1:Surface Soil Saturation	Saturation ratio of the surface soil layer	DERIVED(none)
Default value used		
F2:Unsaturated Zone Saturation	Saturation ratio of the unsaturated zone	DERIVED(none)
Default value used		
INFIL:Infiltration Rate	Net rate of infiltration to aquifer	DERIVED(m/y)
Default value used		
SCSST:Soil Classification	SCS soil classification ID	DISCRETE CUMULATIVE(none)
Default value used		Value Probability 1.00E+00 1.00E-04 2.00E+00 1.34E-03 3.00E+00 1.06E-02 4.00E+00 2.51E-02 5.00E+00 6.17E-02 6.00E+00 1.09E-01 7.00E+00 1.62E-01 8.00E+00 2.12E-01 9.00E+00 2.85E-01 1.00E+01 5.10E-01 1.10E+01 7.58E-01 1.20E+01 1.00E+00

NDEV:Porosity Probability	Relative porosity value within the distribution for this soil type	UNIFORM(none)
Default value used		Lower Limit 0.00E+00 Upper Limit 1.00E+00
KSDEV:Permeability Probability	Relative permeability value within the distribution for this soil type	UNIFORM(none)
Default value used		Lower Limit 0.00E+00 Upper Limit 1.00E+00
BDEV:Parameter "b" Probability	Relative value of "b" parameter within the distribution for this soil type	UNIFORM(none)
Default value used		Lower Limit 0.00E+00 Upper Limit 1.00E+00
AP:Water Application Rate	Total water application rate on cultivated area	CONTINUOUS LINEAR(m/y)
Default value used		Value / Probability 6.07E-01 / 0.00E+00 6.10E-01 / 4.62E-01 6.35E-01 / 4.76E-01 7.62E-01 / 5.40E-01 8.89E-01 / 6.29E-01 1.02E+00 / 7.05E-01 1.14E+00 / 8.04E-01 1.27E+00 / 8.79E-01 1.40E+00 / 9.41E-01 1.52E+00 / 9.82E-01 1.65E+00 / 9.98E-01 1.78E+00 / 1.00E+00
IR:Irrigation Rate	Annual average irrigation rate	CONSTANT(L/m**2-d)
Default value used		Value 1.29E+00
RHO1:Surface Soil Density	Bulk density of soil in the surface soil layer	DERIVED(g/mL)
Default value used		
RHO2:Unsaturated Zone Density	Bulk density of soil in the unsaturated zone	DERIVED(g/mL)
Default value used		
Ksat1:Surface Soil Permeabiliy	Saturated permeability of the surface soil layer	DERIVED(cm/sec)
Default value used		
VDR:Volume of Water Consumed	Volume of water withdrawn for consumptive use	CONSTANT(L)
Default value used		Value 1.18E+05
VSW:Volume of Water in Pond	Volume of water in the pond	CONSTANT(L)

Default value used		Value 1.30E+06
AR:Cultivated Area	Area of land cultivated	DERIVED(m**2)
Default value used		
sh:Soil Moisture Content	Moisture content of soil	DERIVED(none)
Default value used		
TTG:Gardening Period	Total time in gardening period	CONSTANT(days)
Default value used		Value 9.00E+01
TD:Drinking-water consumption period	Drinking-water consumption period	CONSTANT(days)
Default value used		Value 3.65E+02
THV(1):Holdup Period : Leafy	Holdup period for leafy vegetables	CONSTANT(days)
Default value used		Value 1.00E+00
THV(2):Holdup Period : Other vegetables	Holdup period for other vegetables	CONSTANT(days)
Default value used		Value 1.40E+01
THV(3):Holdup Period : Fruits	Holdup period for fruits	CONSTANT(days)
Default value used		Value 1.40E+01
THV(4):Holdup Period : Grains	Holdup period for grains	CONSTANT(days)
Default value used		Value 1.40E+01
THA(1):Holdup Period : Beef	Holdup period for beef	CONSTANT(days)
Default value used		Value 2.00E+01
THA(2):Holdup Period : Poultry	Holdup period for poultry	CONSTANT(days)
Default value used		Value 1.00E+00
THA(3):Holdup Period : Milk	Holdup period for milk	CONSTANT(days)
Default value used		Value 1.00E+00
THA(4):Holdup Period : Eggs	Holdup period for eggs	CONSTANT(days)
Default value used		Value 1.00E+00
TGV(1):Growing Period : Leafy	Minimum growing period for leafy vegetables	CONSTANT(days)
Default value used		Value 4.50E+01
TGV(2):Growing Period : Other vegetables	Minimum growing period for other vegetables	CONSTANT(days)

Default value used		Value 9.00E+01
TGV(3):Growing Period : Fruits	Minimum growing period for fruits	CONSTANT(days)
Default value used		Value 9.00E+01
TGV(4):Growing Period : Grains	Minimum growing period for grains	CONSTANT(days)
Default value used		Value 9.00E+01
TGF(1):Growing Period : Beef Forage	Minimum growing period for forage consumed by beef cattle	CONSTANT(days)
Default value used		Value 3.00E+01
TGF(2):Growing Period : Poultry Forage	Minimum growing period for forage consumed by poultry	DERIVED(days)
Default value used		
TGF(3):Growing Period : Milk Cow Forage	Minimum growing period for forage consumed by milk cows	DERIVED(days)
Default value used		
TGF(4):Growing Period : Layer Hen Forage	Minimum growing period for forage consumed by layer hens	DERIVED(days)
Default value used		
TGG(1):Growing Period : Beef Cow Grain	Minimum growing period for stored grain consumed by beef cattle	CONSTANT(days)
Default value used		Value 9.00E+01
TGG(2):Growing Period : Poultry Grain	Minimum growing period for stored grain consumed by poultry	DERIVED(days)
Default value used		
TGG(3):Growing Period : Milk Cow Grain	Minimum growing period for stored grain consumed by milk cows	DERIVED(days)
Default value used		
TGG(4):Growing Period : Layer Hen Grain	Minimum growing period for stored grain consumed by layer hens	DERIVED(days)
Default value used		
TGH(1):Growing Period : Beef Cow Hay	Minimum growing period for stored hay consumed by beef cattle	CONSTANT(days)
Default value used		Value 4.50E+01
TGH(2):Growing Period : Poultry Hay	Minimum growing period for stored hay consumed by poultry	DERIVED(days)
Default value used		

TGH(3):Growing Period : Milk Cow Hay	Minimum growing period for stored hay consumed by milk cows	DERIVED(days)
Default value used		
TGH(4):Growing Period : Layer Hen Hay	Minimum growing period for stored hay consumed by layer hens	DERIVED(days)
Default value used		
RV(1):Interception Fraction : Leafy	Interception fraction for leafy vegetables	UNIFORM(none)
Default value used		Lower Limit 1.00E-01 Upper Limit 6.00E-01
RV(2):Interception Fraction : Other vegetables	Interception fraction for other vegetables	UNIFORM(none)
Default value used		Lower Limit 1.00E-01 Upper Limit 6.00E-01
RV(3):Interception Fraction : Fruits	Interception fraction for fruits	UNIFORM(none)
Default value used		Lower Limit 1.00E-01 Upper Limit 6.00E-01
RV(4):Interception Fraction : Grains	Interception fraction for grains	UNIFORM(none)
Default value used		Lower Limit 1.00E-01 Upper Limit 6.00E-01
RF(1):Interception Fraction : Beef Forage	Interception fraction for beef cattle forage	UNIFORM(none)
Default value used		Lower Limit 1.00E-01 Upper Limit 6.00E-01
RF(2):Interception Fraction : Poultry forage	Interception fraction for poultry forage	DERIVED(none)
Default value used		
RF(3):Interception Fraction : Milk Cow Forage	Interception fraction for milk cow forage	DERIVED(none)
Default value used		
RF(4):Interception Fraction : Layer Hen Forage	Interception fraction for layer hen forage	DERIVED(none)
Default value used		
RG(1):Interception Fraction : Beef Cow Grain	Interception fraction for beef cattle grain	UNIFORM(none)

Default value used		Lower Limit 1.00E-01 Upper Limit 6.00E-01
RG(2):Interception Fraction : Poultry Grain	Interception fraction for poultry grain	DERIVED(none)
Default value used		
RG(3):Interception Fraction : Milk Cow Grain	Interception fraction for milk cow grain	DERIVED(none)
Default value used		
RG(4):Interception Fraction : Layer Hen Grain	Interception fraction for layer hen grain	DERIVED(none)
Default value used		
RH(1):Interception Fraction : Beef Cow Hay	Interception fraction for beef cattle hay	DERIVED(none)
Default value used		
RH(2):Interception Fraction : Poultry Hay	Interception fraction for poultry hay	DERIVED(none)
Default value used		
RH(3):Interception Fraction : Milk Cow Hay	Interception fraction for milk cow hay	DERIVED(none)
Default value used		
RH(4):Interception Fraction : Layer Hen Hay	Interception fraction for layer hen hay	DERIVED(none)
Default value used		
YV(1):Crop Yield : Leafy	Crop yield for leafy vegetables	CONTINUOUS LINEAR(kg wet wt/m**2)

Default value used

Value	Probability
2.70E+00	0.00E+00
2.71E+00	1.60E-03
2.74E+00	6.00E-03
2.76E+00	1.76E-02
2.78E+00	4.36E-02
2.80E+00	8.48E-02
2.82E+00	1.56E-01
2.85E+00	2.57E-01
2.87E+00	3.64E-01
2.89E+00	5.00E-01
2.91E+00	6.39E-01
2.93E+00	7.46E-01
2.96E+00	8.42E-01
2.98E+00	9.09E-01
3.00E+00	9.60E-01
3.02E+00	9.84E-01
3.04E+00	9.94E-01

		3.07E+00 9.97E-01 3.09E+00 9.99E-01 3.11E+00 1.00E+00 3.13E+00 1.00E+00 3.15E+00 1.00E+00
YV(2):Crop Yield : Other	Crop yield for other vegetables	CONTINUOUS LINEAR(kg wet wt/m**2)
Default value used		Value Probability 2.26E+00 0.00E+00 2.29E+00 8.00E-04 2.30E+00 1.20E-03 2.31E+00 6.40E-03 2.33E+00 1.52E-02 2.34E+00 3.28E-02 2.35E+00 7.44E-02 2.36E+00 1.40E-01 2.38E+00 2.49E-01 2.39E+00 3.80E-01 2.40E+00 5.30E-01 2.42E+00 6.61E-01 2.43E+00 7.88E-01 2.44E+00 8.86E-01 2.45E+00 9.42E-01 2.47E+00 9.75E-01 2.48E+00 9.88E-01 2.49E+00 9.96E-01 2.51E+00 9.97E-01 2.52E+00 9.99E-01 2.53E+00 1.00E+00 2.54E+00 1.00E+00
YV(3):Crop Yield : Fruits	Crop yield for fruits	CONTINUOUS LINEAR(kg wet wt/m**2)
Default value used		Value Probability 2.17E+00 0.00E+00 2.20E+00 1.20E-03 2.21E+00 2.40E-03 2.23E+00 6.80E-03 2.25E+00 1.80E-02 2.27E+00 4.36E-02 2.29E+00 7.64E-02 2.31E+00 1.38E-01 2.32E+00 2.14E-01 2.34E+00 3.27E-01 2.36E+00 4.50E-01 2.38E+00 5.76E-01 2.40E+00 6.87E-01 2.42E+00 7.88E-01 2.43E+00 8.68E-01 2.45E+00 9.25E-01 2.47E+00 9.60E-01 2.49E+00 9.81E-01

		2.51E+00 9.92E-01 2.53E+00 9.98E-01 2.54E+00 1.00E+00 2.56E+00 1.00E+00
YV(4):Crop Yield : Grains	Crop yield for grains	CONTINUOUS LINEAR(kg wet wt/m**2)
Default value used		Value Probability 2.85E-01 0.00E+00 2.90E-01 6.00E-04 3.02E-01 2.80E-03 3.14E-01 9.40E-03 3.26E-01 2.14E-02 3.38E-01 5.42E-02 3.50E-01 1.08E-01 3.62E-01 2.02E-01 3.74E-01 3.15E-01 3.86E-01 4.50E-01 3.98E-01 5.92E-01 4.10E-01 7.20E-01 4.23E-01 8.26E-01 4.35E-01 9.03E-01 4.47E-01 9.51E-01 4.59E-01 9.77E-01 4.71E-01 9.91E-01 4.83E-01 9.96E-01 4.95E-01 9.99E-01 5.07E-01 1.00E+00 5.19E-01 1.00E+00 5.31E-01 1.00E+00
YF(1):Crop Yield : Beef Forage	Crop yield for beef cattle forage	BETA(kg dry wt forage/m**2)
Default value used		Lower Limit 3.70E-01 Upper Limit 5.24E-01 p 2.36E+00 q 1.40E+00
YF(2):Crop Yield : Poultry Forage	Crop yield for poultry forage	DERIVED(kg wet wt forage/m**2)
Default value used		
YF(3):Crop Yield : Milk Cow Forage	Crop yield for milk cow forage	DERIVED(kg wet wt forage/m**2)
Default value used		
YF(4):Crop Yield : Layer Hen Forage	Crop yield for layer hen forage	DERIVED(kg wet wt forage/m**2)
Default value used		
YG(1):Crop Yield : Beef Cow Grain	Crop yield for beef cattle grain	NORMAL(kg dry wt grain /m**2)

Default value used		Mean 5 78E-01 Standard Deviation 7.77E-02
YG(2):Crop Yield : Poultry Grain	Crop yield for poultry grain	DERIVED(kg wet wt grain /m**2)
Default value used		
YG(3):Crop Yield : Milk Cow Grain	Crop yield for milk cow grain	DERIVED(kg wet wt grain /m**2)
Default value used		
YG(4):Crop Yield : Layer Hen Grain	Crop yield for layer hen grain	DERIVED(kg wet wt grain /m**2)
Default value used		
YH(1):Crop Yield : Beef Cow Hay	Crop yield for beef cattle hay	DERIVED(kg wet wt/m**2)
Default value used		
YH(2):Crop Yield : Poultry Hay	Crop yield for poultry hay	DERIVED(kg wet wt/m**2)
Default value used		
YH(3):Crop Yield : Milk Cow Hay	Crop yield for milk cow hay	DERIVED(kg wet wt/m**2)
Default value used		
YH(4):Crop Yield : Layer Hen Hay	Crop yield for layer hen hay	DERIVED(kg wet wt/m**2)
Default value used		
WV(1):Wet/dry : Leafy Vegetables	Wet/dry conversion factor for leafy vegetables	CONTINUOUS LINEAR(none)
Default value used		Value Probability 3 32E-02 0.00E+00 4.89E-02 3.45E-02 5 47E-02 6.91E-02 5.96E-02 1.04E-01 6.36E-02 1.38E-01 6.70E-02 1.73E-01 7.05E-02 2.07E-01 7.38E-02 2.42E-01 7.48E-02 2.50E-01 7.72E-02 2.76E-01 8.03E-02 3.11E-01 8.34E-02 3.45E-01 8.66E-02 3.80E-01 9.00E-02 4.15E-01 9.36E-02 4.49E-01 9.73E-02 4.84E-01 9.91E-02 4.99E-01 1.01E-01 5.18E-01 1.05E-01 5 53E-01 1.09E-01 5.87E-01

	1.13E-01 6.22E-01 1.18E-01 6.56E-01 1.23E-01 6.91E-01 1.29E-01 7.25E-01 1.33E-01 7.50E-01 1.35E-01 7.60E-01 1.42E-01 7.94E-01 1.50E-01 8.29E-01 1.59E-01 8.64E-01 1.70E-01 8.98E-01 1.85E-01 9.33E-01 2.10E-01 9.67E-01 2.56E-01 9.91E-01 3.24E-01 1.00E+00
WV(2):Wet/dry : Other Vegetables	Wet/dry conversion factor for other vegetables
Default value used	Value Probability 3.58E-02 0.00E+00 4.87E-02 3.45E-02 5.46E-02 6.91E-02 5.90E-02 1.04E-01 6.29E-02 1.38E-01 6.69E-02 1.73E-01 7.02E-02 2.07E-01 7.34E-02 2.42E-01 7.41E-02 2.50E-01 7.65E-02 2.76E-01 7.99E-02 3.11E-01 8.32E-02 3.45E-01 8.66E-02 3.80E-01 9.05E-02 4.15E-01 9.41E-02 4.49E-01 9.82E-02 4.84E-01 9.98E-02 4.99E-01 1.02E-01 5.18E-01 1.06E-01 5.53E-01 1.09E-01 5.87E-01 1.14E-01 6.22E-01 1.19E-01 6.56E-01 1.24E-01 6.91E-01 1.29E-01 7.25E-01 1.33E-01 7.50E-01 1.35E-01 7.60E-01 1.42E-01 7.94E-01 1.50E-01 8.29E-01 1.59E-01 8.64E-01 1.70E-01 8.98E-01 1.87E-01 9.33E-01 2.12E-01 9.67E-01 2.62E-01 9.91E-01 3.13E-01 1.00E+00

WV(3):Wet/dry : Fruit	Wet/dry conversion factor for fruits	CONTINUOUS LINEAR(none)
Default value used		Value Probability 3.66E-02 0.00E+00 4.87E-02 3.45E-02 5.45E-02 6.91E-02 5.93E-02 1.04E-01 6.31E-02 1.38E-01 6.72E-02 1.73E-01 7.10E-02 2.07E-01 7.44E-02 2.42E-01 7.52E-02 2.50E-01 7.78E-02 2.76E-01 8.13E-02 3.11E-01 8.45E-02 3.45E-01 8.78E-02 3.80E-01 9.11E-02 4.15E-01 9.46E-02 4.49E-01 9.82E-02 4.84E-01 9.97E-02 4.99E-01 1.02E-01 5.18E-01 1.06E-01 5.53E-01 1.10E-01 5.87E-01 1.14E-01 6.22E-01 1.19E-01 6.56E-01 1.24E-01 6.91E-01 1.29E-01 7.25E-01 1.34E-01 7.50E-01 1.35E-01 7.60E-01 1.42E-01 7.94E-01 1.49E-01 8.29E-01 1.58E-01 8.64E-01 1.70E-01 8.98E-01 1.87E-01 9.33E-01 2.14E-01 9.67E-01 2.58E-01 9.91E-01 3.25E-01 1.00E+00
WV(4):Wet/dry : Grain	Wet/dry conversion factor for grains	CONSTANT(none)
Default value used		Value 8.80E-01
WF(1):Wet/dry : Beef Cow Forage	Wet/dry conversion factor for beef cattle forage	BETA(none)
Default value used		Lower Limit 1.83E-01 Upper Limit 3.23E-01 p 1.15E+00 q 1.18E+00
WF(2):Wet/dry : Poultry Forage	Wet/dry conversion factor for poultry forage	DERIVED(none)
Default value used		

WF(3):Wet/dry : Milk Cow Forage	Wet/dry conversion factor for milk cow forage	DERIVED(none)
Default value used		
WF(4):Wet/dry : Layer Hen Forage	Wet/dry conversion factor for layer hen forage	DERIVED(none)
Default value used		
WG(1):Wet/dry : Beef Cow Grain	Wet/dry conversion factor for beef cattle grain	CONSTANT(none)
Default value used		Value 8.80E-01
WG(2):Wet/dry : Poultry Grain	Wet/dry conversion factor for poultry grain	DERIVED(none)
Default value used		
WG(3):Wet/dry : Milk Cow Grain	Wet/dry conversion factor for milk cow grain	DERIVED(none)
Default value used		
WG(4):Wet/dry : Layer Hen Grain	Wet/dry conversion factor for layer hen grain	DERIVED(none)
Default value used		
WH(1):Wet/dry : Beef Cow Hay	Wet/dry conversion factor for beef cattle hay	DERIVED(none)
Default value used		
WH(2):Wet/dry : Poultry Hay	Wet/dry conversion factor for poultry hay	DERIVED(none)
Default value used		
WH(3):Wet/dry : Milk Cow Hay	Wet/dry conversion factor for milk cow hay	DERIVED(none)
Default value used		
WH(4):Wet/dry : Layer Hen Hay	Wet/dry conversion factor for layer hen hay	DERIVED(none)
Default value used		
QF(1):Ingestion Rate : Beef Cow Forage	Ingestion rate for beef cattle forage	BETA(kg dry wt forage/d)
Default value used		Lower Limit 1.69E+00 Upper Limit 2.29E+00 p 1.99E+00 q 9.11E-01
QF(2):Ingestion Rate : Poultry Forage	Ingestion rate for poultry forage	BETA(kg dry wt forage/d)
Default value used		Lower Limit 3.48E-03 Upper Limit 2.82E-02 p 1.51E+00 q 1.41E+00

QF(3):Ingestion Rate : Milk Cow Forage	Ingestion rate for milk cow forage	CONTINUOUS LINEAR(kg dry wt forage/d)

Default value used

Value	Probability
6.35E+00	0.00E+00
6.77E+00	3.45E-02
6.96E+00	6.91E-02
7.10E+00	1.04E-01
7.24E+00	1.38E-01
7.35E+00	1.73E-01
7.47E+00	2.07E-01
7.57E+00	2.42E-01
7.60E+00	2.50E-01
7.67E+00	2.76E-01
7.77E+00	3.11E-01
7.87E+00	3.45E-01
7.98E+00	3.80E-01
8.08E+00	4.15E-01
8.18E+00	4.49E-01
8.31E+00	4.84E-01
8.37E+00	4.99E-01
8.42E+00	5.18E-01
8.54E+00	5.53E-01
8.67E+00	5.87E-01
8.81E+00	6.22E-01
8.95E+00	6.56E-01
9.10E+00	6.91E-01
9.26E+00	7.25E-01
9.38E+00	7.50E-01
9.45E+00	7.60E-01
9.68E+00	7.94E-01
9.93E+00	8.29E-01
1.02E+01	8.64E-01
1.06E+01	8.98E-01
1.11E+01	9.33E-01
1.20E+01	9.67E-01
1.33E+01	9.91E-01
1.53E+01	1.00E+00

QF(4):Ingestion Rate : Layer Hen Forage	Ingestion rate for layer hen forage	BETA(kg dry wt forage/d)

Default value used

Lower Limit	1.19E-02
Upper Limit	2.22E-02
p	1.45E+00
q	7.92E-01

QG(1):Ingestion Rate : Beef Cattle Grain	Ingestion rate for beef cattle grain	BETA(kg dry wt grain/d)

Default value used

Lower Limit	1.69E+00
Upper Limit	2.29E+00
p	1.99E+00
q	9.11E-01

QG(2):Ingestion Rate : Poultry Grain	Ingestion rate for poultry grain	BETA(kg dry wt grain/d)
Default value used		Lower Limit 1.04E-02 Upper Limit 8.45E-02 p 1.51E+00 q 1.41E+00
QG(3):Ingestion Rate : Milk Cow Grain	Ingestion rate for milk cow grain	NORMAL(kg dry wt grain/d)
Default value used		Mean 1.71E+00 Standard Deviation 2.62E-01
QG(4):Ingestion Rate : Layer Hen Grain	Ingestion rate for layer hen grain	BETA(kg dry wt grain/d)
Default value used		Lower Limit 3.58E-02 Upper Limit 6.67E-02 p 1.43E+00 q 7.92E-01
QH(1):Ingestion Rate : Beef Cattle Hay	Ingestion rate for beef cattle hay	BETA(kg dry wt hay/d)
Default value used		Lower Limit 3.38E+00 Upper Limit 4.58E+00 p 1.99E+00 q 9.11E-01
QH(2):Ingestion Rate : Poultry Hay	Ingestion rate for poultry hay	CONSTANT(kg dry wt hay/d)
Default value used		Value 0.00E+00
QH(3):Ingestion Rate : Milk Cow Hay	Ingestion rate for milk cow hay	CONTINUOUS LINEAR(kg dry wt hay/d)
Default value used		Value / Probability 5.12E+00 / 0.00E+00 5.43E+00 / 3.45E-02 5.57E+00 / 6.91E-02 5.68E+00 / 1.04E-01 5.79E+00 / 1.38E-01 5.89E+00 / 1.73E-01 5.98E+00 / 2.07E-01 6.06E+00 / 2.42E-01 6.08E+00 / 2.50E-01 6.14E+00 / 2.76E-01 6.22E+00 / 3.11E-01 6.30E+00 / 3.45E-01 6.38E+00 / 3.80E-01 6.46E+00 / 4.15E-01 6.54E+00 / 4.49E-01 6.63E+00 / 4.84E-01 6.67E+00 / 4.99E-01 6.72E+00 / 5.18E-01 6.81E+00 / 5.53E-01 6.92E+00 / 5.87E-01

		7.03E+00 6.22E-01 7.13E+00 6.56E-01 7.26E+00 6.91E-01 7.39E+00 7.25E-01 7.49E+00 7.50E-01 7.56E+00 7.60E-01 7.70E+00 7.94E-01 7.89E+00 8.29E-01 8.11E+00 8.64E-01 8.39E+00 8.98E-01 8.75E+00 9.33E-01 9.44E+00 9.67E-01 1.05E+01 9.91E-01 1.27E+01 1.00E+00
QH(4):Ingestion Rate : Layer Hen Hay	Ingestion rate for layer hen hay	CONSTANT (kg dry wt hay/d)
Default value used		Value 0.00E+00
QW(1):Water Rate : Beef Cattle	Water ingestion rate for beef cattle	CONSTANT (L/d)
Default value used		Value 5.00E+01
QW(2):Water Rate : Poultry	Water ingestion rate for poultry	CONSTANT (L/d)
Default value used		Value 3.00E-01
QW(3):Water Rate : Milk Cows	Water ingestion rate for milk cows	CONSTANT (L/d)
Default value used		Value 6.00E+01
QW(4):Water Rate : Layer Hens	Water ingestion rate for layer hens	CONSTANT (L/d)
Default value used		Value 3.00E-01
QD(1):Soil Fraction : Beef Cattle	Soil intake fraction for beef cattle	CONSTANT (none)
Default value used		Value 2.00E-02
QD(2):Soil Fraction : Poultry	Soil intake fraction for poultry	CONSTANT (none)
Default value used		Value 1.00E-01
QD(3):Soil Fraction : Milk Cows	Soil intake fraction for milk cows	CONSTANT (none)
Default value used		Value 2.00E-02
QD(4):Soil Fraction : Layer Hens	Soil intake fraction for layer hens	CONSTANT (none)
Default value used		Value 1.00E-01
MLV(1):Mass-Loading : Leafy Vegetables	Mass-loading factor for leafy vegetables	CONSTANT (none)

Default value used		Value 1.00E-01
MLV(2):Mass-Loading : Other Vegetables	Mass-loading factor for other vegetables	CONSTANT(none)
Default value used		Value 1.00E-01
MLV(3):Mass-Loading : Fruits	Mass-loading factor for fruits	CONSTANT(none)
Default value used		Value 1.00E-01
MLV(4):Mass-Loading : Grains	Mass-loading factor for grains	CONSTANT(none)
Default value used		Value 1.00E-01
LAMBDW:Weathering Rate	Weathering rate for activity removal from plants	CONSTANT(1/d)
Default value used		Value 4.95E-02
MLF(1):Mass-Loading : Beef Cow Forage	Mass-loading factor for beef cattle forage	CONSTANT(none)
Default value used		Value 1.00E-01
MLF(2):Mass-Loading : Poultry Forage	Mass-loading factor for poultry forage	CONSTANT(none)
Default value used		Value 1.00E-01
MLF(3):Mass-Loading : Milk Cow Forage	Mass-loading factor for milk cow forage	CONSTANT(none)
Default value used		Value 1.00E-01
MLF(4):Mass-Loading : Layer Hen Forage	Mass-loading factor for layer hen forage	CONSTANT(none)
Default value used		Value 1.00E-01
MLG(1):Mass-Loading : Beef Cattle Grain	Mass-loading factor for beef cattle grain	CONSTANT(none)
Default value used		Value 1.00E-01
MLG(2):Mass-Loading : Poultry Grain	Mass-loading factor for poultry grain	CONSTANT(none)
Default value used		Value 1.00E-01
MLG(3):Mass-Loading : Milk Cow Grain	Mass-loading factor for milk cow grain	CONSTANT(none)
Default value used		Value 1.00E-01
MLG(4):Mass-Loading : Layer Hen Grain	Mass-loading factor for layer hen grain	CONSTANT(none)
Default value used		Value 1.00E-01
MLH(1):Mass-Loading : Beef Cattle Hay	Mass-loading factor for beef cattle hay	CONSTANT(none)
Default value used		Value 1.00E-01

MLH(2):Mass-Loading : Poultry Hay	Mass-loading factor for poultry hay	CONSTANT (none)
Default value used		Value 1.00E-01
MLH(3):Mass-Loading : Milk Cow Hay	Mass-loading factor for milk cow hay	CONSTANT (none)
Default value used		Value 1.00E-01
MLH(4):Mass-Loading : Layer Hen Hay	Mass-loading factor for layer hen hay	CONSTANT (none)
Default value used		Value 1.00E-01
TFF(1):Feeding Period : Beef Cow Forage	Feeding period for beef cattle forage	CONSTANT (days)
Default value used		Value 3.65E+02
TFF(2):Feeding Period : Poultry Forage	Feeding period for poultry forage	CONSTANT (days)
Default value used		Value 3.65E+02
TFF(3):Feeding Period : Milk Cow Forage	Feeding period for milk cow forage	CONSTANT (days)
Default value used		Value 3.65E+02
TFF(4):Feeding Period : Layer Hen Forage	Feeding period for layer hen forage	CONSTANT (days)
Default value used		Value 3.65E+02
TFG(1):Feeding Period : Beef Cattle Grain	Feeding period for beef cattle grain	CONSTANT (days)
Default value used		Value 3.65E+02
TFG(2):Feeding Period : Poultry Grain	Feeding period for poultry grain	CONSTANT (days)
Default value used		Value 3.65E+02
TFG(3):Feeding Period : Milk Cow Grain	Feeding period for milk cow grain	CONSTANT (days)
Default value used		Value 3.65E+02
TFG(4):Feeding Period : Layer Hen Grain	Feeding period for layer hen grain	CONSTANT (days)
Default value used		Value 3.65E+02
TFH(1):Feeding Period : Beef Cattle Hay	Feeding period for beef cattle hay	CONSTANT (days)
Default value used		Value 3.65E+02
TFH(2):Feeding Period : Poultry Hay	Feeding period for poultry hay	CONSTANT (days)
Default value used		Value 3.65E+02

TFH(3):Feeding Period : Milk Cow Hay	Feeding period for milk cow hay	CONSTANT (days)
Default value used		Value 3.65E+02
TFH(4):Feeding Period : Layer Hen Hay	Feeding period for layer hen hay	CONSTANT (days)
Default value used		Value 3.65E+02
TFW(1):Water Period : Beef Cattle	Water ingestion period for beef cattle	CONSTANT (days)
Default value used		Value 3.65E+02
TFW(2):Water Period : Poultry	Water ingestion period for poultry	CONSTANT (days)
Default value used		Value 3.65E+02
TFW(3):Water Period : Milk Cows	Water ingestion period for milk cows	CONSTANT (days)
Default value used		Value 3.65E+02
TFW(4):Water Period : Layer Hens	Water ingestion period for layer hens	CONSTANT (days)
Default value used		Value 3.65E+02
fha(1):Hydrogen Fraction : Beef Cattle	Hydrogen fraction for beef cattle	CONSTANT (none)
Default value used		Value 1.00E-01
fha(2):Hydrogen Fraction : Poultry	Hydrogen fraction for poultry	CONSTANT (none)
Default value used		Value 1.00E-01
fha(3):Hydrogen Fraction : Milk Cows	Hydrogen fraction for milk cows	CONSTANT (none)
Default value used		Value 1.10E-01
fha(4):Hydrogen Fraction : Eggs	Hydrogen fraction for eggs	CONSTANT (none)
Default value used		Value 1.10E-01
fhv(1):Hydrogen Fraction : Leafy Vegetables	Hydrogen fraction for leafy vegetables	CONSTANT (none)
Default value used		Value 1.00E-01
fhv(2):Hydrogen Fraction : Other Vegetables	Hydrogen fraction for other vegetables	CONSTANT (none)
Default value used		Value 1.00E-01
fhv(3):Hydrogen Fraction : Fruits	Hydrogen fraction for fruits	CONSTANT (none)

Default value used		Value 1.00E-01
fhv(4):Hydrogen Fraction : Grains	Hydrogen fraction for grains	CONSTANT (none)
Default value used		Value 6.80E-02
fhf(1):Hydrogen Fraction : Beef Cow Forage	Hydrogen fraction for beef cattle forage	CONSTANT (none)
Default value used		Value 1.00E-01
fhf(2):Hydrogen Fraction : Poultry Forage	Hydrogen fraction for poultry forage	CONSTANT (none)
Default value used		Value 1.00E-01
fhf(3):Hydrogen Fraction : Milk Cow Forage	Hydrogen fraction for milk cow forage	CONSTANT (none)
Default value used		Value 1.00E-01
fhf(4):Hydrogen Fraction : Layer Hen Forage	Hydrogen fraction for layer hen forage	CONSTANT (none)
Default value used		Value 1.00E-01
fhh(1):Hydrogen Fraction : Beef Cattle Hay	Hydrogen fraction for beef cattle hay	CONSTANT (none)
Default value used		Value 1.00E-01
fhh(2):Hydrogen Fraction : Poultry Hay	Hydrogen fraction for poultry hay	CONSTANT (none)
Default value used		Value 1.00E-01
fhh(3):Hydrogen Fraction : Milk Cow Hay	Hydrogen fraction for milk cow hay	CONSTANT (none)
Default value used		Value 1.00E-01
fhh(4):Hydrogen Fraction : Layer Hen Hay	Hydrogen fraction for layer hen hay	CONSTANT (none)
Default value used		Value 1.00E-01
fhg(1):Hydrogen Fraction : Beef Cattle Grain	Hydrogen fraction for beef cattle grain	CONSTANT (none)
Default value used		Value 6.80E-02
fhg(2):Hydrogen Fraction : Poultry Grain	Hydrogen fraction for poultry grain	CONSTANT (none)
Default value used		Value 6.80E-02

fhg(3):Hydrogen Fraction : Milk Cow Grain	Hydrogen fraction for milk cow grain	CONSTANT(none)
Default value used		Value 6.80E-02
fhg(4):Hydrogen Fraction : Layer Hen Grain	Hydrogen fraction for layer hen grain	CONSTANT(none)
Default value used		Value 6.80E-02
fhd016:Hydrogen Fraction : Soil	Fraction of hydrogen in soil	DERIVED(none)
Default value used		
sasvh:Tritium Equivalence: Plant/Soil	Tritium equivalence: plant/soil	CONSTANT(none)
Default value used		Value 1.00E+00
sawvh:Tritium Equivalence: Plant/Water	Tritium equivalence: plant/water	CONSTANT(none)
Default value used		Value 1.00E+00
satah:Tritium Equivalence: Animal Products	Tritium equivalence: animal product intake	CONSTANT(none)
Default value used		Value 1.00E+00
YA(1):Animal Product Yield : Beef Cattle	Annual yield of beef per individual animal	CONSTANT(kg/y)
Default value used		Value 2.09E+02
YA(2):Animal Product Yield : Poultry	Annual yield of chicken per individual animal	CONSTANT(kg/y)
Default value used		Value 1.53E+00
YA(3):Animal Product Yield : Milk Cows	Annual yield of milk per individual animal	CONSTANT(L/y)
Default value used		Value 7.41E+03
YA(4):Animal Product Yield : Layer Hens	Annual yield of eggs per individual animal	CONSTANT(kg/y)
Default value used		Value 1.26E+01
AREXt:External Exposure Area	Minimum surface area to which resident is exposed via external radiation during residential period	CONSTANT(m**2)
Default value used		Value 1.00E+02
ARInh:Inhalation Exposure Area	Minimum surface area to which resident is exposed via inhalation during residential period	CONSTANT(m**2)

Default value used		Value 1.00E+02
ARIng:Secondary Ingestion Exposure Area	Minimum surface area to which resident is exposed via secondary ingestion during residential period	CONSTANT(m**2)
Default value used		Value 1.00E+02
ARAgr:Agricultural Exposure Area	Minimum surface area to which resident is exposed via any agricultural product during residential period	DERIVED(m**2)
Default value used		
ARH2O:Groundwater Exposure Area	Minimum surface area to which resident is exposed via groundwater during residential period	DERIVED(m**2)
Default value used		
ARAll:Exposure Area	Minimum surface area to which resident is exposed via any pathway during the residential period	DERIVED(m**2)
Default value used		

Element Dependant Parameters

Parameter Name	Description	Distribution
Pb:Coefficient	Partition coefficient for Pb	NORMAL(Log10(mL/g))
Default value used		Mean 3.38E+00 Standard Deviation 1.20E+00
Bi:Coefficient	Partition coefficient for Bi	NORMAL(Log10(mL/g))
Default value used		Mean 2.65E+00 Standard Deviation 1.40E+00
Po:Coefficient	Partition coefficient for Po	NORMAL(Log10(mL/g))
Default value used		Mean 2.26E+00 Standard Deviation 7.30E-01
Rn:Coefficient	Partition coefficient for Rn	CONSTANT(mL/g)
Default value used		Value 0.00E+00
Ra:Coefficient	Partition coefficient for Ra	NORMAL(Log10(mL/g))
Default value used		Mean 3.55E+00 Standard Deviation 7.40E-01
Pb:Leafy	Leafy plant concentration factor for Pb	LOGNORMAL-N(pCi/kg dry-wt leafy per pCi/kg soil)
Default value used		Mean of Ln(X) -3.10E+00 Standard Deviation of Ln 9.04E-01

Bi:Leafy	Leafy plant concentration factor for Bi	LOGNORMAL-N(pCi/kg dry-wt leafy per pCi/kg soil)
Default value used		Mean of Ln(X) -3.35E+00 Standard Deviation of Ln 9.04E-01
Po:Leafy	Leafy plant concentration factor for Po	LOGNORMAL-N(pCi/kg dry-wt leafy per pCi/kg soil)
Default value used		Mean of Ln(X) -5.99E+00 Standard Deviation of Ln 9.04E-01
Rn:Leafy	Leafy plant concentration factor for Rn	CONSTANT(pCi/kg dry-wt leafy per pCi/kg soil)
Default value used		Value 0.00E+00
Ra:Leafy	Leafy plant concentration factor for Ra	LOGNORMAL-N(pCi/kg dry-wt leafy per pCi/kg soil)
Default value used		Mean of Ln(X) -4.20E+00 Standard Deviation of Ln 9.04E-01
Pb:Root	Root plant concentration factor for Pb	LOGNORMAL-N(pCi/kg dry-wt roots per pCi/kg soil)
Default value used		Mean of Ln(X) -4.71E+00 Standard Deviation of Ln 9.04E-01
Bi:Root	Root plant concentration factor for Bi	LOGNORMAL-N(pCi/kg dry-wt roots per pCi/kg soil)
Default value used		Mean of Ln(X) -5.30E+00 Standard Deviation of Ln 9.04E-01
Po:Root	Root plant concentration factor for Po	LOGNORMAL-N(pCi/kg dry-wt roots per pCi/kg soil)
Default value used		Mean of Ln(X) -7.82E+00 Standard Deviation of Ln 9.04E-01
Rn:Root	Root plant concentration factor for Rn	CONSTANT(pCi/kg dry-wt roots per pCi/kg soil)
Default value used		Value 0.00E+00
Ra:Root	Root plant concentration factor for Ra	LOGNORMAL-N(pCi/kg dry-wt roots per pCi/kg soil)
Default value used		Mean of Ln(X) -6.50E+00 Standard Deviation of Ln 9.04E-01
Pb:Fruit	Fruit concentration factor for Pb	LOGNORMAL-N(pCi/kg dry-wt fruit per pCi/kg soil)
Default value used		Mean of Ln(X) -4.71E+00 Standard Deviation of Ln 9.04E-01
Bi:Fruit	Fruit concentration factor for Bi	LOGNORMAL-N(pCi/kg dry-wt fruit per pCi/kg soil)
Default value used		Mean of Ln(X) -5.30E+00 Standard Deviation of Ln 9.04E-01
Po:Fruit	Fruit concentration factor for Po	LOGNORMAL-N(pCi/kg dry-wt fruit per pCi/kg soil)
Default value used		Mean of Ln(X) -7.82E+00 Standard Deviation of Ln 9.04E-01

Rn:Fruit	Fruit concentration factor for Rn	CONSTANT(pCi/kg dry-wt fruit per pCi/kg soil)
Default value used		Value 0.00E+00
Ra:Fruit	Fruit concentration factor for Ra	LOGNORMAL-N(pCi/kg dry-wt fruit per pCi/kg soil)
Default value used		Mean of Ln(X) -6.50E+00 Standard Deviation of Ln 9.04E-01
Pb:Grain	Grain concentration factor for Pb	LOGNORMAL-N(pCi/kg dry-wt grain per pCi/kg soil)
Default value used		Mean of Ln(X) -4.71E+00 Standard Deviation of Ln 9.04E-01
Bi:Grain	Grain concentration factor for Bi	LOGNORMAL-N(pCi/kg dry-wt grain per pCi/kg soil)
Default value used		Mean of Ln(X) -5.30E+00 Standard Deviation of Ln 9.04E-01
Po:Grain	Grain concentration factor for Po	LOGNORMAL-N(pCi/kg dry-wt grain per pCi/kg soil)
Default value used		Mean of Ln(X) -7.82E+00 Standard Deviation of Ln 9.04E-01
Rn:Grain	Grain concentration factor for Rn	CONSTANT(pCi/kg dry-wt grain per pCi/kg soil)
Default value used		Value 0.00E+00
Ra:Grain	Grain concentration factor for Ra	LOGNORMAL-N(pCi/kg dry-wt grain per pCi/kg soil)
Default value used		Mean of Ln(X) -6.50E+00 Standard Deviation of Ln 9.04E-01
Pb:Beef	Beef transfer factor for Pb	CONSTANT(d/kg)
Default value used		Value 3.00E-04
Bi:Beef	Beef transfer factor for Bi	CONSTANT(d/kg)
Default value used		Value 4.00E-04
Po:Beef	Beef transfer factor for Po	CONSTANT(d/kg)
Default value used		Value 3.00E-04
Rn:Beef	Beef transfer factor for Rn	CONSTANT(d/kg)
Default value used		Value 0.00E+00
Ra:Beef	Beef transfer factor for Ra	CONSTANT(d/kg)
Default value used		Value 2.50E-04
Pb:Poultry	Poultry transfer factor for Pb	CONSTANT(d/kg)
Default value used		Value 2.00E-01
Bi:Poultry	Poultry transfer factor for Bi	CONSTANT(d/kg)
Default value used		Value 1.00E-01
Po:Poultry	Poultry transfer factor for Po	CONSTANT(d/kg)
Default value used		Value 9.00E-01

Rn:Poultry	Poultry transfer factor for Rn	CONSTANT(d/kg)
Default value used		Value 0.00E+00
Ra:Poultry	Poultry transfer factor for Ra	CONSTANT(d/kg)
Default value used		Value 3.00E-02
Pb:Milk	Milk transfer factor for Pb	CONSTANT(d/L)
Default value used		Value 2.50E-04
Bi:Milk	Milk transfer factor for Bi	CONSTANT(d/L)
Default value used		Value 5.00E-04
Po:Milk	Milk transfer factor for Po	CONSTANT(d/L)
Default value used		Value 3.50E-04
Rn:Milk	Milk transfer factor for Rn	CONSTANT(d/L)
Default value used		Value 0.00E+00
Ra:Milk	Milk transfer factor for Ra	CONSTANT(d/L)
Default value used		Value 4.50E-04
Pb:Eggs	Egg transfer factor for Pb	CONSTANT(d/kg)
Default value used		Value 8.00E-01
Bi:Eggs	Egg transfer factor for Bi	CONSTANT(d/kg)
Default value used		Value 8.00E-01
Po:Eggs	Egg transfer factor for Po	CONSTANT(d/kg)
Default value used		Value 7.00E+00
Rn:Eggs	Egg transfer factor for Rn	CONSTANT(d/kg)
Default value used		Value 0.00E+00
Ra:Eggs	Egg transfer factor for Ra	CONSTANT(d/kg)
Default value used		Value 2.00E-05
Pb:Factor	Bioaccumulation factor for Pb in fish	CONSTANT(pCi/kg wet-wt fish per pCi/L water)
Default value used		Value 1.00E+02
Bi:Factor	Bioaccumulation factor for Bi in fish	CONSTANT(pCi/kg wet-wt fish per pCi/L water)
Default value used		Value 1.50E+01
Po:Factor	Bioaccumulation factor for Po in fish	CONSTANT(pCi/kg wet-wt fish per pCi/L water)
Default value used		Value 5.00E+02
Rn:Factor	Bioaccumulation factor for Rn in fish	CONSTANT(pCi/kg wet-wt fish per pCi/L water)
Default value used		Value 0.00E+00
Ra:Factor	Bioaccumulation factor for Ra in fish	CONSTANT(pCi/kg wet-wt fish per pCi/L water)
Default value used		Value 7.00E+01

Correlation Coefficients:

Parameter One	Parameter Two	Correlation Coefficient
KSDEV:Permeability Probability	BDEV:Parameter "b" Probability	-0.35
Default value used		
NDEV:Porosity Probability	BDEV:Parameter "b" Probability	-0.35
Default value used		

Summary Results:

90.00% of the 100 calculated TEDE values are < 3.80E+03 mrem/year .
The 95 % Confidence Interval for the 0.9 quantile value of TEDE is 3.66E+03 to 4.10E+03 mrem/year

Detailed Results:

Note: All reported values are the upper bound of the symmetric 95% confidence interval for the 0.9 quantile value

Concentration at Time of Peak Dose:

Nuclide	Soil Concentration (pCi/g)	Water Concentration (pCi/g)
210Bi	9.63E+01	1.30E-08
210Po	9.63E+01	4.81E-09
226Ra	9.49E+01	4.65E-12
222Rn	9.49E+01	1.37E-06
218Po	9.49E+01	1.37E-06
214Pb	9.49E+01	1.37E-06
218At	1.90E-02	2.74E-10
214Bi	9.49E+01	1.37E-06
214Po	9.49E+01	1.37E-06
210Pb	9.63E+01	1.38E-08

Pathway Dose from All Nuclides (mrem)

All Pathways Dose	Agricultural	Drinking Water	Surface Water	External	Inhalation	Secondary Ingestion	Irrigation
4.10E+03	3.65E+03	3.91E-08	1.36E-07	4.37E+02	9.96E-01	1.17E+01	1.08E-07

Radionuclide Dose through All Active Pathways (mrem)

Nuclide	All Pathways Dose
226Ra	4.58E+02
222Rn	9.83E-02
218Po	2.27E-03
214Pb	5.81E+01
218At	0.00E+00
214Bi	3.78E+02
214Po	2.07E-02
210Pb	2.26E+03
210Bi	2.87E+00
210Po	9.13E+02
All Nuclides	4.10E+03

Dose from Each Nuclide through Each Active Pathway (mrem)

Nuclide	Agricultural	Drinking Water	Surface Water	External	Inhalation	Secondary Ingestion	Irrigation
226Ra	4.54E+02	2.84E-12	4.55E-12	1.42E+00	2.66E-01	1.78E+00	3.54E-12
222Rn	0.00E+00	0.00E+00	0.00E+00	9.83E-02	0.00E+00	0.00E+00	0.00E+00
218Po	0.00E+00	0.00E+00	0.00E+00	2.27E-03	0.00E+00	0.00E+00	0.00E+00
214Pb	2.07E-01	3.95E-10	0.00E+00	5.79E+01	2.42E-04	8.40E-04	1.60E-12
218At	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
214Bi	9.36E-02	1.79E-10	0.00E+00	3.78E+02	2.04E-04	3.80E-04	7.25E-13
214Po	0.00E+00	0.00E+00	0.00E+00	2.07E-02	0.00E+00	0.00E+00	0.00E+00
210Pb	2.25E+03	3.43E-08	8.42E-08	1.15E-01	4.27E-01	7.31E+00	8.48E-08
210Bi	2.70E+00	3.85E-11	1.42E-11	1.64E-01	6.16E-03	8.72E-03	1.02E-10
210Po	9.04E+02	4.22E-09	5.19E-08	2.14E-03	2.96E-01	2.59E+00	2.31E-08

CONTENTS

FIGURES

ATTACHMENTS

$DCGL_W$ = derived concentration guideline equivalent to the average concentration of residual radioactivity that would give a dose of 25 mrem/y to the average member of the critical group, in the same units as "Conc."

r = monetary discount rate in units per year

λ = radiological decay constant for the radionuclide in units per year

N = number of years over which the collective dose will be calculated.

In accordance with NUREG 1757, the total cost for remedial action is calculated using the following equation:

$$Cost_T = Cost_R + Cost_{WD} + Cost_{ACC} + Cost_{TF} + Cost_{WDose} + Cost_{PDose} + Cost_{other} \quad \textbf{Equation 2}$$

where

$Cost_R$ = monetary cost of the remedial action

$Cost_{WD}$ = monetary cost for transport and disposal of the waste generated by the action

$Cost_{ACC}$ = monetary cost of worker accidents during the remedial action

$Cost_{TF}$ = monetary cost of traffic fatalities during transporting of the waste

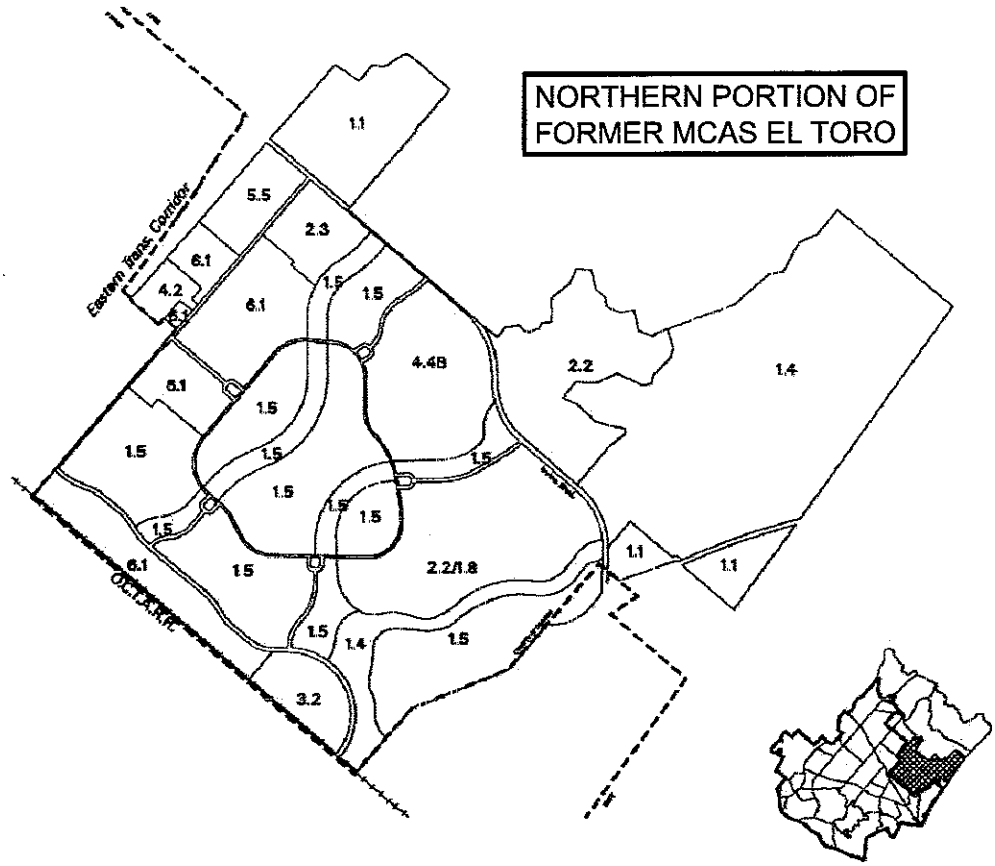
$Cost_{WDose}$ = monetary cost of dose received by workers performing the remedial action and transporting waste to the disposal facility

$Cost_{PDose}$ = monetary cost of the dose to the public from excavation, transport, and disposal of waste

$Cost_{other}$ = other costs as appropriate for the particular situation

Since the residual radioactivity that is ALARA is the concentration, ($Conc_A$), at which the benefit from removal equals the cost of removal, the following equation is derived in Appendix N of the NUREG 1757 by setting total cost ($Cost_T$) equal to the present worth of the collective dose averted:

ZONING ORDINANCE MAP
PLANNING AREA 51



OVERLAY ZONE

LEGEND:

1.1	Exclusive Agriculture
1.4	Preservation
1.5	Recreation
2.2	Low-Density Residential
2.3	Medium-Density Residential
3.2	Transit Oriented Dev.
4.2	Community Commercial
4.4B	Commercial Recreation
5.5	Medical and Science
6.1	Institutional

SOURCE:

Zoning Ordinance, City of Irvine
(Codified through Ord. No. 05-16, Enacted July 12, 2005 [Supplement No. 24])

FS Addendum-Appendix B		Final
Land Use - Former MCAS El Toro		
IRP Site 8		
Date: 02-06	Former MCAS El Toro	Figure B-1
Project No. 29307	EarthTech, A Tyco International Ltd. Company	

File: L:\work\29307\work\Sites 8, 12\CAD\FS Addendum\Final\Appendix B\B-1.dwg Time: Feb 14, 2006 - 12:48pm

$$\frac{Conc_A}{DCGL_w} = \frac{Cost_T}{\$2000 \times P_D \times 0.025 \times F \times A} \times \frac{r+\lambda}{1-e^{-(r+\lambda)N}} \qquad \textbf{Equation 3}$$

Based on the ratio of $Conc_A$ to $DCGL_W$, it can be determined if the dose limit (25 mrem/y) or the requirement for achieving ALARA dictates the cleanup goal at the site. If the ratio of $Conc_A$ to $DCGL_W$ is greater than 1, the cleanup goal would be dictated by the ability to meet the dose limit of 25 mrem/y. If the ratio of $Conc_A$ to $DCGL_W$ is less than 1, the cleanup goal would be dictated by the ability to achieve ALARA.

The ratio of $Conc_A$ to $DCGL_W$ for Site 8 was calculated to be approximately 462. The values of parameters used to calculate the ratio are presented in Table 2. It should be noted that the value used for $Cost_T$ for calculating the ratio of $Conc_A$ to $DCGL_W$ included only $Cost_R$ (monetary cost of the remedial action) and $Cost_{WD}$ (monetary cost for transport and disposal of the waste generated by the action) (see equation 2). Other costs including, $Cost_{ACC}$ (monetary cost of worker accidents during the remedial action), $Cost_{TF}$ (monetary cost of traffic fatalities during transporting of the waste), $Cost_{Wdose}$ (monetary cost of dose received by workers performing the remedial action and transporting waste to the disposal facility), and $Cost_{Pdose}$ (monetary cost of the dose to the public from excavation, transport , and disposal of waste), were not included. This ensures a more conservative ALARA analysis.

The ratio of $Conc_A$ to $DCGL_W$ for Site 8 suggests that meeting the dose limit of 25 mrem/y would be limiting in determining the target cleanup goal by a considerable margin compared to requirement to meet ALARA. Therefore, any value of residual Ra-226 concentration, including 1 pCi/g above background, that leads to a TEDE of less than or equal to 25 mrem/y is ALARA at Site 8.

Table 2: Parameter Values for Calculating the Ratio of $Conc_A$ to $DCGL_W$

Parameter	Value	Rationale / Source
$Cost_T$	$1,702,000	Estimated cost for Alternative 3. See Section 5.2.3.7 of the FS Addendum (Final)
P_D	0.0004 person per square meter	Table N.2 (Acceptable Parameter Value for Use in ALARA Analyses) in Appendix N of NUREG 1757.
F	0.99	(Site-specific Average Ra-226 concentration [95.98 pCi/g] – 1 pCi/g) / (Site-specific Average Ra-226 concentration [95.98 pCi/g)
A	5665 square meters	Area encompassed by Units 1 and 4.
r	0.03 per year	Table N.2 (Acceptable Parameter Value for Use in ALARA Analyses) in Appendix N of NUREG 1757.
λ	0.000433 per year	Radiological decay constant for Ra-226
N	1000 years	Table N.2 (Acceptable Parameter Value for Use in ALARA Analyses) in Appendix N of NUREG 1757.

6. Conclusion and Recommendations

The results of the dose and risk assessments indicate that a Ra-226 concentration of 1 pCi/g above background satisfies the NRC dose criteria of 25 mrem/y and results in a risk within the NCP risk management range of 10^{-6} to 10^{-4}, for a residential (unrestricted release) scenario. Additionally, a cost-benefit analysis shows that this concentration of Ra-226 is ALARA. Therefore, DON proposes to use a DCGL and target cleanup goal for Ra-226 of 1 pCi/g above background at Site 8.

7. References

Environmental Protection Agency, United States (EPA). 1997. *Memorandum: Establishment of Cleanup Levels for CERCLA Sites with Radioactive Contamination.* OSWER No. 9200.4-18. 22 August.

Environmental Protection Agency, United States (EPA). 2002. *Memorandum: Distribution of OSWER of Radionuclide Preliminary Remediation Goals (PRGs) for Superfund Electronic Calculator. OSWER No. 9355.01-83A. 07 February.*

Earth Tech, Inc (Earth Tech). 2005. *Draft Feasibility Study Addendum, Operable Unit 3A, IRP Site 8, Former Marine Corps Air Station, El Toro, California.* Honolulu, HI. March.

United States Nuclear Regulatory Commission (NRC). 2003. *Consolidated NMSS Decommissioning Guidance. Characterization, Survey, and Determination of Radiological Criteria.* NUREG-1757. Office of Nuclear Material Safety and Safeguards. Washington, DC. September.

Yu, C.; Zielen, A.J.; Cheng, J.-J.; LePoire, D.J.; Gnanapragasam, E.; Kamboj, S.; Arnish, J.; Wallo III, A.; Williams, W.A.; and Peterson, H. 2001. *User's Manual for RESRAD Version 6.* Environmental Assessment Division, Argonne National Laboratory (ANL/EAD-4). July.

Attachment B-1
Risk Screening Summary for Target Cleanup Goal – EPA PRG Calculator

Preliminary Remediation Goals for Radionuclides

Topics for Key Radiation Guidances and Reports

Equation Values for Residential Soil

Parameter	Value	Parameter	Value
Target Risk (unitless)	8.1E-5	Exposure Duration (yr)	30
Adult Exposure Duration (yr)	24	Child Exposure Duration (yr)	6
Exposure Frequency (day/yr)	350	Adult Intake Rate (mg/day)	100
Child Intake Rate (mg/day)	200	Age-adjusted Ingestion Factor (mg-yr/kg-day)	120
Adult Inhalation Rate (m^3/day)	20	Child Inhalation Rate (m^3/day)	10
Age-adjusted Inhalation Factor (mg-yr/kg-day)	18	Time of Exposure (yr)	30
Outdoor Exposure Time Fraction (unitless)	0.073	Indoor Exposure Time Fraction (unitless)	0.683
Indoor Dilution Factor (unitless)	0.4	Area Correction Factor (unitless)	0.9
Gamma Shielding Factor (m^3/kg)	0.4	Age-adjusted Fruit Consumption Rate (kg/yr)	17.48
Age-Adjusted Vegetable Consumption Rate (kg/yr)	9.08	Contaminated Plant Fraction (unitless)	0.25
Child Vegetable Consumption Rate (kg/yr)	3.8	Adult Vegetable Consumption Rate (kg/yr)	10.4
Child Fruit Consumption Rate (kg/yr)	5.4	Adult Fruit Consumption Rate (kg/yr)	20.5
Particulate Emission Factor (m^3/kg)	9.00E+10	City (Climatic Zone)	LosAngeles (III)

Surface Area (acres)	2.0	Q/C (g/m^2-s per kg/m^3)	53.3
Fraction of Vegetative Cover	0.5	Mean Annual Windspeed (m/s)	3.31
Equivalent Threshold Value of Windspeed at 7m (m/s)	11.32	F(x) (unitless)	0.00474

Radionuclide Preliminary Remediation Goals for Residential Soil

Chemical	Residential Exposure Soil Ingestion Slope Factor (Risk/pCi)*	Inhalation Slope Factor (Risk/pCi)	External Exposure Slope Factor (Risk/yr per pCi/g)	Food Ingestion Slope Factor (Risk/pCi)	Soil-to-Plant Transfer Factor (pCi plant/pCi soil)	PRG (pCi/g)	PRG (mg/kg)
Ra-226+D decaychain	7.30E-10	1.16E-08	8.49E-06	5.15E-10	0.04	1.01E+00	1.02E-06

* Soil Ingestion Slope Factor is calculated for a lifetime of 70 years.

For table of soil to plant transfer factors click here

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Attachment B-2
Dose Assessment Summary for Target Cleanup Goal – RESRAD Computer Code Version 6.3

Table of Contents

Part I: Mixture Sums and Single Radionuclide Guidelines

Dose Conversion Factor (and Related) Parameter Summary
File: FGR 13 MORBIDITY

Menu	Parameter	Current Value	Base Case*	Parameter Name
B-1	Dose conversion factors for inhalation, mrem/pCi:			
B-1	Pb-210+D	2.320E-02	1.360E-02	DCF2(1)
B-1	Ra-226+D	8.594E-03	8.580E-03	DCF2(2)
D-1	Dose conversion factors for ingestion, mrem/pCi:			
D-1	Pb-210+D	7.276E-03	5.370E-03	DCF3(1)
D-1	Ra-226+D	1.321E-03	1.320E-03	DCF3(2)
D-34	Food transfer factors:			
D-34	Pb-210+D , plant/soil concentration ratio, dimensionless	1.000E-02	1.000E-02	RTF(1,1)
D-34	Pb-210+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	8.000E-04	8.000E-04	RTF(1,2)
D-34	Pb-210+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	3.000E-04	3.000E-04	RTF(1,3)
D-34				
D-34	Ra-226+D , plant/soil concentration ratio, dimensionless	4.000E-02	4.000E-02	RTF(2,1)
D-34	Ra-226+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-03	1.000E-03	RTF(2,2)
D-34	Ra-226+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	1.000E-03	1.000E-03	RTF(2,3)
D-5	Bioaccumulation factors, fresh water, L/kg:			
D-5	Pb-210+D , fish	3.000E+02	3.000E+02	BIOFAC(1,1)
D-5	Pb-210+D , crustacea and mollusks	1.000E+02	1.000E+02	BIOFAC(1,2)
D-5				
D-5	Ra-226+D , fish	5.000E+01	5.000E+01	BIOFAC(2,1)
D-5	Ra-226+D , crustacea and mollusks	2.500E+02	2.500E+02	BIOFAC(2,2)

*Base Case means Default.Lib w/o Associate Nuclide contributions.

Site-Specific Parameter Summary

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R011	Area of contaminated zone (m**2)	5.670E+03	1.000E+04	---	AREA
R011	Thickness of contaminated zone (m)	5.000E-01	2.000E+00	---	THICK0
R011	Length parallel to aquifer flow (m)	1.000E+02	1.000E+02	---	LCZPAQ
R011	Basic radiation dose limit (mrem/yr)	2.500E+01	3.000E+01	---	BRDL
R011	Time since placement of material (yr)	0.000E+00	0.000E+00	---	TI
R011	Times for calculations (yr)	1.000E+00	1.000E+00	---	T(2)
R011	Times for calculations (yr)	3.000E+00	3.000E+00	---	T(3)
R011	Times for calculations (yr)	1.000E+01	1.000E+01	---	T(4)
R011	Times for calculations (yr)	3.000E+01	3.000E+01	---	T(5)
R011	Times for calculations (yr)	1.000E+02	1.000E+02	---	T(6)
R011	Times for calculations (yr)	3.000E+02	3.000E+02	---	T(7)
R011	Times for calculations (yr)	1.000E+03	1.000E+03	---	T(8)
R011	Times for calculations (yr)	not used	0.000E+00	---	T(9)
R011	Times for calculations (yr)	not used	0.000E+00	---	T(10)
R012	Initial principal radionuclide (pCi/g): Ra-226	1.000E+00	0.000E+00	---	S1(2)
R012	Concentration in groundwater (pCi/L): Ra-226	not used	0.000E+00	---	W1(2)
R013	Cover depth (m)	0.000E+00	0.000E+00	---	COVER0
R013	Density of cover material (g/cm**3)	not used	1.500E+00	---	DENSCV
R013	Cover depth erosion rate (m/yr)	not used	1.000E-03	---	VCV
R013	Density of contaminated zone (g/cm**3)	1.500E+00	1.500E+00	---	DENSCZ
R013	Contaminated zone erosion rate (m/yr)	1.000E-03	1.000E-03	---	VCZ
R013	Contaminated zone total porosity	4.000E-01	4.000E-01	---	TPCZ
R013	Contaminated zone field capacity	2.000E-01	2.000E-01	---	FCCZ
R013	Contaminated zone hydraulic conductivity (m/yr)	1.000E+01	1.000E+01	---	HCCZ
R013	Contaminated zone b parameter	5.300E+00	5.300E+00	---	BCZ
R013	Average annual wind speed (m/sec)	2.000E+00	2.000E+00	---	WIND
R013	Humidity in air (g/m**3)	not used	8.000E+00	---	HUMID
R013	Evapotranspiration coefficient	5.000E-01	5.000E-01	---	EVAPTR
R013	Precipitation (m/yr)	1.000E+00	1.000E+00	---	PRECIP
R013	Irrigation (m/yr)	2.000E-01	2.000E-01	---	RI
R013	Irrigation mode	overhead	overhead	---	IDITCH
R013	Runoff coefficient	2.000E-01	2.000E-01	---	RUNOFF
R013	Watershed area for nearby stream or pond (m**2)	1.000E+06	1.000E+06	---	WAREA
R013	Accuracy for water/soil computations	1.000E-03	1.000E-03	---	EPS
R014	Density of saturated zone (g/cm**3)	1.500E+00	1.500E+00	---	DENSAQ
R014	Saturated zone total porosity	4.000E-01	4.000E-01	---	TPSZ
R014	Saturated zone effective porosity	2.000E-01	2.000E-01	---	EPSZ

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R014	Saturated zone field capacity	2.000E-01	2.000E-01	---	FCSZ
R014	Saturated zone hydraulic conductivity (m/yr)	1.000E+02	1.000E+02	---	HCSZ
R014	Saturated zone hydraulic gradient	2.000E-02	2.000E-02	---	HGWT
R014	Saturated zone b parameter	5.300E+00	5.300E+00	---	BSZ
R014	Water table drop rate (m/yr)	1.000E-03	1.000E-03	---	VWT
R014	Well pump intake depth (m below water table)	1.000E+01	1.000E+01	---	DWIBWT
R014	Model: Nondispersion (ND) or Mass-Balance (MB)	ND	ND	---	MODEL
R014	Well pumping rate (m**3/yr)	2.500E+02	2.500E+02	---	UW
R015	Number of unsaturated zone strata	1	1	---	NS
R015	Unsat. zone 1, thickness (m)	4.000E+00	4.000E+00	---	H(1)
R015	Unsat. zone 1, soil density (g/cm**3)	1.500E+00	1.500E+00	---	DENSUZ(1)
R015	Unsat. zone 1, total porosity	4.000E-01	4.000E-01	---	TPUZ(1)
R015	Unsat. zone 1, effective porosity	2.000E-01	2.000E-01	---	EPUZ(1)
R015	Unsat. zone 1, field capacity	2.000E-01	2.000E-01	---	FCUZ(1)
R015	Unsat. zone 1, soil-specific b parameter	5.300E+00	5.300E+00	---	BUZ(1)
R015	Unsat. zone 1, hydraulic conductivity (m/yr)	1.000E+01	1.000E+01	---	HCUZ(1)
R016	Distribution coefficients for Ra-226				
R016	Contaminated zone (cm**3/g)	7.000E+01	7.000E+01	---	DCNUCC(2)
R016	Unsaturated zone 1 (cm**3/g)	7.000E+01	7.000E+01	---	DCNUCU(2,1)
R016	Saturated zone (cm**3/g)	7.000E+01	7.000E+01	---	DCNUCS(2)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	9.495E-03	ALEACH(2)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(2)
R016	Distribution coefficients for daughter Pb-210				
R016	Contaminated zone (cm**3/g)	1.000E+02	1.000E+02	---	DCNUCC(1)
R016	Unsaturated zone 1 (cm**3/g)	1.000E+02	1.000E+02	---	DCNUCU(1,1)
R016	Saturated zone (cm**3/g)	1.000E+02	1.000E+02	---	DCNUCS(1)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	6.652E-03	ALEACH(1)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(1)
R017	Inhalation rate (m**3/yr)	8.400E+03	8.400E+03	---	INHALR
R017	Mass loading for inhalation (g/m**3)	1.000E-04	1.000E-04	---	MLINH
R017	Exposure duration	3.000E+01	3.000E+01	---	ED
R017	Shielding factor, inhalation	4.000E-01	4.000E-01	---	SHF3
R017	Shielding factor, external gamma	7.000E-01	7.000E-01	---	SHF1
R017	Fraction of time spent indoors	5.000E-01	5.000E-01	---	FIND

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R017	Fraction of time spent outdoors (on site)	2.500E-01	2.500E-01	---	FOTD
R017	Shape factor flag, external gamma	1.000E+00	1.000E+00	>0 shows circular AREA.	FS
R017	Radii of shape factor array (used if FS = -1):				
R017	Outer annular radius (m), ring 1:	not used	5.000E+01	---	RAD_SHAPE(1)
R017	Outer annular radius (m), ring 2:	not used	7.071E+01	---	RAD_SHAPE(2)
R017	Outer annular radius (m), ring 3:	not used	0.000E+00	---	RAD_SHAPE(3)
R017	Outer annular radius (m), ring 4:	not used	0.000E+00	---	RAD_SHAPE(4)
R017	Outer annular radius (m), ring 5:	not used	0.000E+00	---	RAD_SHAPE(5)
R017	Outer annular radius (m), ring 6:	not used	0.000E+00	---	RAD_SHAPE(6)
R017	Outer annular radius (m), ring 7:	not used	0.000E+00	---	RAD_SHAPE(7)
R017	Outer annular radius (m), ring 8:	not used	0.000E+00	---	RAD_SHAPE(8)
R017	Outer annular radius (m), ring 9:	not used	0.000E+00	---	RAD_SHAPE(9)
R017	Outer annular radius (m), ring 10:	not used	0.000E+00	---	RAD_SHAPE(10)
R017	Outer annular radius (m), ring 11:	not used	0.000E+00	---	RAD_SHAPE(11)
R017	Outer annular radius (m), ring 12:	not used	0.000E+00	---	RAD_SHAPE(12)
R017	Fractions of annular areas within AREA:				
R017	Ring 1	not used	1.000E+00	---	FRACA(1)
R017	Ring 2	not used	2.732E-01	---	FRACA(2)
R017	Ring 3	not used	0.000E+00	---	FRACA(3)
R017	Ring 4	not used	0.000E+00	---	FRACA(4)
R017	Ring 5	not used	0.000E+00	---	FRACA(5)
R017	Ring 6	not used	0.000E+00	---	FRACA(6)
R017	Ring 7	not used	0.000E+00	---	FRACA(7)
R017	Ring 8	not used	0.000E+00	---	FRACA(8)
R017	Ring 9	not used	0.000E+00	---	FRACA(9)
R017	Ring 10	not used	0.000E+00	---	FRACA(10)
R017	Ring 11	not used	0.000E+00	---	FRACA(11)
R017	Ring 12	not used	0.000E+00	---	FRACA(12)
R018	Fruits, vegetables and grain consumption (kg/yr)	1.600E+02	1.600E+02	---	DIET(1)
R018	Leafy vegetable consumption (kg/yr)	1.400E+01	1.400E+01	---	DIET(2)
R018	Milk consumption (L/yr)	9.200E+01	9.200E+01	---	DIET(3)
R018	Meat and poultry consumption (kg/yr)	6.300E+01	6.300E+01	---	DIET(4)
R018	Fish consumption (kg/yr)	5.400E+00	5.400E+00	---	DIET(5)
R018	Other seafood consumption (kg/yr)	9.000E-01	9.000E-01	---	DIET(6)
R018	Soil ingestion rate (g/yr)	3.650E+01	3.650E+01	---	SOIL
R018	Drinking water intake (L/yr)	5.100E+02	5.100E+02	---	DWI
R018	Contamination fraction of drinking water	1.000E+00	1.000E+00	---	FDW

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R018	Contamination fraction of household water	not used	1.000E+00	---	FHHW
R018	Contamination fraction of livestock water	1.000E+00	1.000E+00	---	FLW
R018	Contamination fraction of irrigation water	1.000E+00	1.000E+00	---	FIRW
R018	Contamination fraction of aquatic food	5.000E-01	5.000E-01	---	FR9
R018	Contamination fraction of plant food	-1	-1	0.500E+00	FPLANT
R018	Contamination fraction of meat	-1	-1	0.283E+00	FMEAT
R018	Contamination fraction of milk	-1	-1	0.283E+00	FMILK
R019	Livestock fodder intake for meat (kg/day)	6.800E+01	6.800E+01	---	LFI5
R019	Livestock fodder intake for milk (kg/day)	5.500E+01	5.500E+01	---	LFI6
R019	Livestock water intake for meat (L/day)	5.000E+01	5.000E+01	---	LWI5
R019	Livestock water intake for milk (L/day)	1.600E+02	1.600E+02	---	LWI6
R019	Livestock soil intake (kg/day)	5.000E-01	5.000E-01	---	LSI
R019	Mass loading for foliar deposition (g/m**3)	1.000E-04	1.000E-04	---	MLFD
R019	Depth of soil mixing layer (m)	1.500E-01	1.500E-01	---	DM
R019	Depth of roots (m)	9.000E-01	9.000E-01	---	DROOT
R019	Drinking water fraction from ground water	1.000E+00	1.000E+00	---	FGWDW
R019	Household water fraction from ground water	not used	1.000E+00	---	FGWHH
R019	Livestock water fraction from ground water	1.000E+00	1.000E+00	---	FGWLW
R019	Irrigation fraction from ground water	1.000E+00	1.000E+00	---	FGWIR
R19B	Wet weight crop yield for Non-Leafy (kg/m**2)	7.000E-01	7.000E-01	---	YV(1)
R19B	Wet weight crop yield for Leafy (kg/m**2)	1.500E+00	1.500E+00	---	YV(2)
R19B	Wet weight crop yield for Fodder (kg/m**2)	1.100E+00	1.100E+00	---	YV(3)
R19B	Growing Season for Non-Leafy (years)	1.700E-01	1.700E-01	---	TE(1)
R19B	Growing Season for Leafy (years)	2.500E-01	2.500E-01	---	TE(2)
R19B	Growing Season for Fodder (years)	8.000E-02	8.000E-02	---	TE(3)
R19B	Translocation Factor for Non-Leafy	1.000E-01	1.000E-01	---	TIV(1)
R19B	Translocation Factor for Leafy	1.000E+00	1.000E+00	---	TIV(2)
R19B	Translocation Factor for Fodder	1.000E+00	1.000E+00	---	TIV(3)
R19B	Dry Foliar Interception Fraction for Non-Leafy	2.500E-01	2.500E-01	---	RDRY(1)
R19B	Dry Foliar Interception Fraction for Leafy	2.500E-01	2.500E-01	---	RDRY(2)
R19B	Dry Foliar Interception Fraction for Fodder	2.500E-01	2.500E-01	---	RDRY(3)
R19B	Wet Foliar Interception Fraction for Non-Leafy	2.500E-01	2.500E-01	---	RWET(1)
R19B	Wet Foliar Interception Fraction for Leafy	2.500E-01	2.500E-01	---	RWET(2)
R19B	Wet Foliar Interception Fraction for Fodder	2.500E-01	2.500E-01	---	RWET(3)
R19B	Weathering Removal Constant for Vegetation	2.000E+01	2.000E+01	---	WLAM
C14	C-12 concentration in water (g/cm**3)	not used	2.000E-05	---	C12WTR
C14	C-12 concentration in contaminated soil (g/g)	not used	3.000E-02	---	C12CZ
C14	Fraction of vegetation carbon from soil	not used	2.000E-02	---	CSOIL

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
C14	Fraction of vegetation carbon from air	not used	9.800E-01	---	CAIR
C14	C-14 evasion layer thickness in soil (m)	not used	3.000E-01	---	DMC
C14	C-14 evasion flux rate from soil (1/sec)	not used	7.000E-07	---	EVSN
C14	C-12 evasion flux rate from soil (1/sec)	not used	1.000E-10	---	REVSN
C14	Fraction of grain in beef cattle feed	not used	8.000E-01	---	AVFG4
C14	Fraction of grain in milk cow feed	not used	2.000E-01	---	AVFG5
C14	DCF correction factor for gaseous forms of C14	not used	0.000E+00	---	CO2F
STOR	Storage times of contaminated foodstuffs (days):				
STOR	Fruits, non-leafy vegetables, and grain	1.400E+01	1.400E+01	---	STOR_T(1)
STOR	Leafy vegetables	1.000E+00	1.000E+00	---	STOR_T(2)
STOR	Milk	1.000E+00	1.000E+00	---	STOR_T(3)
STOR	Meat and poultry	2.000E+01	2.000E+01	---	STOR_T(4)
STOR	Fish	7.000E+00	7.000E+00	---	STOR_T(5)
STOR	Crustacea and mollusks	7.000E+00	7.000E+00	---	STOR_T(6)
STOR	Well water	1.000E+00	1.000E+00	---	STOR_T(7)
STOR	Surface water	1.000E+00	1.000E+00	---	STOR_T(8)
STOR	Livestock fodder	4.500E+01	4.500E+01	---	STOR_T(9)
R021	Thickness of building foundation (m)	not used	1.500E-01	---	FLOOR1
R021	Bulk density of building foundation (g/cm**3)	not used	2.400E+00	---	DENSFL
R021	Total porosity of the cover material	not used	4.000E-01	---	TPCV
R021	Total porosity of the building foundation	not used	1.000E-01	---	TPFL
R021	Volumetric water content of the cover material	not used	5.000E-02	---	PH2OCV
R021	Volumetric water content of the foundation	not used	3.000E-02	---	PH2OFL
R021	Diffusion coefficient for radon gas (m/sec):				
R021	in cover material	not used	2.000E-06	---	DIFCV
R021	in foundation material	not used	3.000E-07	---	DIFFL
R021	in contaminated zone soil	not used	2.000E-06	---	DIFCZ
R021	Radon vertical dimension of mixing (m)	not used	2.000E+00	---	HMIX
R021	Average building air exchange rate (1/hr)	not used	5.000E-01	---	REXG
R021	Height of the building (room) (m)	not used	2.500E+00	---	HRM
R021	Building interior area factor	not used	0.000E+00	---	FAI
R021	Building depth below ground surface (m)	not used	-1.000E+00	---	DMFL
R021	Emanating power of Rn-222 gas	not used	2.500E-01	---	EMANA(1)
R021	Emanating power of Rn-220 gas	not used	1.500E-01	---	EMANA(2)
TITL	Number of graphical time points	32	---	---	NPTS
TITL	Maximum number of integration points for dose	17	---	---	LYMAX
TITL	Maximum number of integration points for risk	257	---	---	KYMAX

Summary of Pathway Selections

Pathway	User Selection
1 -- external gamma	active
2 -- inhalation (w/o radon)	active
3 -- plant ingestion	active
4 -- meat ingestion	active
5 -- milk ingestion	active
6 -- aquatic foods	active
7 -- drinking water	active
8 -- soil ingestion	active
9 -- radon	suppressed
Find peak pathway doses	suppressed

Contaminated Zone Dimensions

Area: 5670.00 square meters
Thickness: 0.50 meters
Cover Depth: 0.00 meters

Initial Soil Concentrations, pCi/g

Ra-226 1.000E+00

Total Dose TDOSE(t), mrem/yr
Basic Radiation Dose Limit = 2.500E+01 mrem/yr
Total Mixture Sum M(t) = Fraction of Basic Dose Limit Received at Time (t)

t (years):	0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
TDOSE(t):	8.941E+00	8.965E+00	8.994E+00	8.967E+00	8.210E+00	4.327E+00	4.524E-01	2.649E+00
M(t):	3.576E-01	3.586E-01	3.597E-01	3.587E-01	3.284E-01	1.731E-01	1.809E-02	1.060E-01

Maximum TDOSE(t): 9.005E+00 mrem/yr at t = 5.40 ± 0.01 years

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 5.404E+00 years
Water Independent Pathways (Innalation excludes radon)

Radio-Nuclide Nuclide	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ra-226	5.869E+00	0.6518	7.128E-04	0.0001	0.000E+00	0.0000	2.947E+00	0.3272	5.963E-02	0.0066	6.305E-02	0.0070	6.589E-02	0.0073
Total	5.869E+00	0.6518	7.128E-04	0.0001	0.000E+00	0.0000	2.947E+00	0.3272	5.963E-02	0.0066	6.305E-02	0.0070	6.589E-02	0.0073

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 5.404E+00 years

Radio-Nuclide	Water Dependent Pathways												All Pathways*	
	Water		Fish		Radon		Plant		Meat		Milk			
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ra-226	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	9.005E+00	1.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	9.005E+00	1.0000

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 0.000E+00 years
Water Independent Pathways (Inhalation excludes radon)

Radio-Nuclide	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ra-226	6.189E+00	0.6922	5.377E-04	0.0001	0.000E+00	0.0000	2.603E+00	0.2912	4.928E-02	0.0055	5.995E-02	0.0067	3.903E-02	0.0044
Total	6.189E+00	0.6922	5.377E-04	0.0001	0.000E+00	0.0000	2.603E+00	0.2912	4.928E-02	0.0055	5.995E-02	0.0067	3.903E-02	0.0044

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 0.000E+00 years
Water Dependent Pathways

Radio-Nuclide	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ra-226	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	8.941E+00	1.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	8.941E+00	1.0000

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+00 years
Water Independent Pathways (Inhalation excludes radon)

Radio-Nuclide	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ra-226	6.129E+00	0.6836	5.741E-04	0.0001	0.000E+00	0.0000	2.679E+00	0.2988	5.155E-02	0.0058	6.068E-02	0.0068	4.458E-02	0.0050
Total	6.129E+00	0.6836	5.741E-04	0.0001	0.000E+00	0.0000	2.679E+00	0.2988	5.155E-02	0.0058	6.068E-02	0.0068	4.458E-02	0.0050

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+00 years
Water Dependent Pathways

Radio-Nuclide	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ra-226	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	8.965E+00	1.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	8.965E+00	1.0000

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+00 years
Water Independent Pathways (Inhalation excludes radon)

Radio-Nuclide	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ra-226	6.009E+00	0.6682	6.413E-04	0.0001	0.000E+00	0.0000	2.811E+00	0.3126	5.549E-02	0.0062	6.189E-02	0.0069	5.486E-02	0.0061
Total	6.009E+00	0.6682	6.413E-04	0.0001	0.000E+00	0.0000	2.811E+00	0.3126	5.549E-02	0.0062	6.189E-02	0.0069	5.486E-02	0.0061

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+00 years
Water Dependent Pathways

Radio-Nuclide	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ra-226	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	8.994E+00	1.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	8.994E+00	1.0000

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+01 years
Water Independent Pathways (Inhalation excludes radon)

Radio-Nuclide	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ra-226	5.610E+00	0.6256	8.245E-04	0.0001	0.000E+00	0.0000	3.142E+00	0.3504	6.589E-02	0.0073	6.453E-02	0.0072	8.337E-02	0.0093
Total	5.610E+00	0.6256	8.245E-04	0.0001	0.000E+00	0.0000	3.142E+00	0.3504	6.589E-02	0.0073	6.453E-02	0.0072	8.337E-02	0.0093

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+01 years
Water Dependent Pathways

Radio-Nuclide	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ra-226	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	8.967E+00	1.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	8.967E+00	1.0000

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+01 years
Water Independent Pathways (Inhalation excludes radon)

Radio-Nuclide	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ra-226	4.609E+00	0.5613	1.044E-03	0.0001	0.000E+00	0.0000	3.340E+00	0.4069	7.603E-02	0.0093	6.331E-02	0.0077	1.208E-01	0.0147
Total	4.609E+00	0.5613	1.044E-03	0.0001	0.000E+00	0.0000	3.340E+00	0.4069	7.603E-02	0.0093	6.331E-02	0.0077	1.208E-01	0.0147

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+01 years
Water Dependent Pathways

Radio-Nuclide	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ra-226	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	8.210E+00	1.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	8.210E+00	1.0000

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+02 years
Water Independent Pathways (Innalation excludes radon)

Radio-Nuclide	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ra-226	2.310E+00	0.5337	7.332E-04	0.0002	0.000E+00	0.0000	1.844E+00	0.4261	4.740E-02	0.0110	3.525E-02	0.0081	9.041E-02	0.0209
Total	2.310E+00	0.5337	7.332E-04	0.0002	0.000E+00	0.0000	1.844E+00	0.4261	4.740E-02	0.0110	3.525E-02	0.0081	9.041E-02	0.0209

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+02 years
Water Dependent Pathways

Radio-Nuclide	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ra-226	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.327E+00	1.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.327E+00	1.0000

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+02 years
Water Independent Pathways (Inhalation excludes radon)

Radio-Nuclide	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ra-226	2.990E-01	0.6609	1.055E-04	0.0002	0.000E+00	0.0000	1.313E-01	0.2903	5.168E-03	0.0114	3.734E-03	0.0083	1.310E-02	0.0290
Total	2.990E-01	0.6609	1.055E-04	0.0002	0.000E+00	0.0000	1.313E-01	0.2903	5.168E-03	0.0114	3.734E-03	0.0083	1.310E-02	0.0290

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+02 years
Water Dependent Pathways

Radio-Nuclide	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ra-226	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.524E-01	1.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.524E-01	1.0000

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+03 years
Water Independent Pathways (Inhalation excludes radon)

Radio-Nuclide	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ra-226	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+03 years
Water Dependent Pathways

Radio-Nuclide	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ra-226	2.416E+00	0.9121	1.964E-02	0.0074	0.000E+00	0.0000	1.866E-01	0.0704	1.236E-02	0.0047	1.421E-02	0.0054	2.649E+00	1.0000
Total	2.416E+00	0.9121	1.964E-02	0.0074	0.000E+00	0.0000	1.866E-01	0.0704	1.236E-02	0.0047	1.421E-02	0.0054	2.649E+00	1.0000

*Sum of all water independent and dependent pathways.

Summary : RESRAD Default Parameters
File : Ste8_All Pathways_Excluding Radon_AreaThicness Changed.RAD

Dose/Source Ratios Summed Over All Pathways
Parent and Progeny Principal Radionuclide Contributions Indicated
DSR(j,t) At Time in Years (mrem/yr)/(pCi/g)

Parent (i)	Product (j)	Thread Fraction	0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
Ra-226+D	Ra-226+D	1.000E+00	8.871E+00	8.779E+00	8.598E+00	7.991E+00	6.482E+00	3.108E+00	3.553E-01	5.408E-01
Ra-226+D	Pb-210+D	1.000E+00	6.966E-02	1.853E-01	3.958E-01	9.762E-01	1.728E+00	1.219E+00	9.710E-02	2.108E+00
Ra-226+D	∑DSR(j)		8.941E+00	8.965E+00	8.994E+00	8.967E+00	8.210E+00	4.327E+00	4.524E-01	2.649E+00

The DSR includes contributions from associated (half-life ≤ 180 days) daughters.

Single Radionuclide Soil Guidelines G(i,t) in pCi/g
Basic Radiation Dose Limit = 2.500E+01 mrem/yr

Nuclide (i)	t= 0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
Ra-226	2.796E+00	2.789E+00	2.780E+00	2.788E+00	3.045E+00	5.777E+00	5.526E+01	9.437E+00

Summed Dose/Source Ratios DSR(i,t) in (mrem/yr)/(pCi/g)
and Single Radionuclide Soil Guidelines G(i,t) in pCi/g
at tmin = time of minimum single radionuclide soil guideline
and at tmax = time of maximum total dose = 5.40 ± 0.01 years

Nuclide (i)	Initial (pCi/g)	tmin (years)	DSR(i,tmin)	G(i,tmin) (pCi/g)	DSR(i,tmax)	G(i,tmax) (pCi/g)
Ra-226	1.000E+00	5.40 ± 0.01	9.005E+00	2.776E+00	9.005E+00	2.776E+00

Individual Nuclide Dose Summed Over All Pathways
Parent Nuclide and Branch Fraction Indicated
DOSE(j,t), mrem/yr

0Nuclide (j)	Parent (i)	THF(i)	t= 0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
Ra-226	Ra-226	1.000E+00	8.871E+00	8.779E+00	8.598E+00	7.991E+00	6.482E+00	3.108E+00	3.553E-01	5.408E-01
Pb-210	Ra-226	1.000E+00	6.966E-02	1.853E-01	3.958E-01	9.762E-01	1.728E+00	1.219E+00	9.710E-02	2.108E+00

THF(i) is the thread fraction of the parent nuclide.

Individual Nuclide Soil Concentration
Parent Nuclide and Branch Fraction Indicated
S(j,t), pCi/g

Nuclide (j)	Parent (i)	THF(i)	t= 0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
Ra-226	Ra-226	1.000E+00	1.000E+00	9.901E-01	9.707E+01	9.055E-01	7.424E-01	3.705E-01	5.087E-02	4.879E-05
Pb-210	Ra-226	1.000E+00	0.000E+00	3.035E-02	8.684E+02	2.457E-01	4.695E-01	3.885E-01	5.685E-02	5.454E-05

THF(i) is the thread fraction of the parent nuclide.
RESCALC.EXE execution time = 1.11 seconds

Appendix C
Applicable or Relevant and Appropriate Requirements

CONTENTS

ATTACHMENT

TABLES

ACRONYMS AND ABBREVIATIONS

§	section
ALARA	as low as is reasonably achievable
AM	action memorandum
AQMD	Air Quality Management District
ARAR	applicable or relevant and appropriate requirement
BACT	Best Available Control Technology
BMP	best management practice
Cal. Code Regs.	California Code of Regulations
Cal/EPA	California Environmental Protection Agency
Cal. Fish & Game Code	California Fish and Game Code
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
C.F.R.	Code of Federal Regulations
ch.	chapter
cm	centimeter
COC	contaminant of concern
DHS	(California) Department of Health Services
DON	Department of the Navy
DOT	Department of Transportation, California
DTSC	(Cal/EPA) Department of Toxic Substances Control
EE/CA	Engineering Evaluation/Cost Analysis
Fed. Reg.	Federal Register
FS	feasibility study
IRP	Installation Restoration Program
LLW	low level radioactive waste
MCAS	Marine Corps Air Station
mrem	millirem
mrem/y	millirem per year
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NPDES	National Pollution Discharge Elimination System
NRC	Nuclear Regulatory Commission
pCi/g	pico-Curie per gram
Ra-226	radium-226
Ra-228	radium-228
RCRA	Resource Conservation and Recovery Act
RI	remedial investigation
ROD	record of decision
RWQCB	(California) Regional Water Quality Control Board
SCAQMD	South Coast Air Quality Management District
SIP	State Implementation Plan
SWPPP	Storm Water Pollution Prevention Plan
SWRCB	(California) State Water Resource Control Board
TBC	to be considered
TCLP	toxicity characteristic leaching procedure
TEDE	total effective dose equivalent
tit.	title
UMTRCA	Uranium Mill Tailings Radiation Control Act
U.S.C.	United States Code
U.S. EPA	United States Environmental Protection Agency

VOC	volatile organic compound

1. INTRODUCTION

This appendix identifies and evaluates potential federal and state of California applicable or relevant and appropriate requirements (ARARs) from the universe of regulations, requirements, and guidance and sets forth the Department of the Navy (DON) determinations regarding those potential ARARs for each remedial action alternative retained for detailed analysis in this feasibility study (FS) addendum for Installation Restoration Program (IRP) Site 8, Units 1 and 4, located at the former Marine Corps Air Station (MCAS) El Toro, California.

This evaluation includes an initial determination of whether the potential ARARs actually qualify as ARARs, and a comparison for stringency between the federal and state regulations to identify the controlling ARARs. The identification of ARARs is an iterative process. The final determination of ARARs will be made by the DON in the record of decision (ROD) or action memorandum (AM), after public review, as part of the response action selection process.

1.1 SUMMARY OF CERCLA AND NCP REQUIREMENTS

Section 121(d) of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA, 42 United States Code [U.S.C.] Section [§] 9621[d]), as amended, states that remedial actions on CERCLA sites must attain (or the decision document must justify the waiver of) any federal or more stringent state environmental standards, requirements, criteria, or limitations that are determined to be legally applicable or relevant and appropriate.

Applicable requirements are those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state law that specifically address the situation at a CERCLA site. The requirement is applicable if the jurisdictional prerequisites of the standard show a direct correspondence when objectively compared to the conditions at the site. An applicable federal requirement is an ARAR. An applicable state requirement is an ARAR only if it is more stringent than federal ARARs. If the requirement is not legally applicable, then the requirement is evaluated to determine whether it is relevant and appropriate. Relevant and appropriate requirements are those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state law that, while not applicable, address problems or situations similar to the circumstances of the proposed response action and are well suited to the conditions of the site (U.S. EPA 1988a). A requirement must be determined to be both relevant and appropriate in order to be considered an ARAR. The criteria for determining relevance and appropriateness are listed in 40 C.F.R. § 300.400(g)(2) and include the following:

- the purpose of the requirement and the purpose of the CERCLA action;
- the medium regulated or affected by the requirement and the medium contaminated or affected at the CERCLA site;
- the substances regulated by the requirement and the substances found at the CERCLA site;
- the actions or activities regulated by the requirement and the response action contemplated at the CERCLA site;
- any variances, waivers, or exemptions of the requirement and their availability for the circumstances at the CERCLA site;
- the type of place regulated and the type of place affected by the release or CERCLA action;

- the type and size of structure or facility regulated and the type and size of structure or facility affected by the release or contemplated by the CERCLA action; and
- any consideration of use or potential use of affected resources in the requirement and the use or potential use of the affected resources at the CERCLA site.

According to CERCLA ARARs guidance (U.S. EPA 1988a), a requirement may be "applicable" or "relevant and appropriate," but not both. Identification of ARARs must be done on a site-specific basis and involve a two-part analysis: first, a determination whether a given requirement is applicable; then, if it is not applicable, a determination whether it is nevertheless both relevant and appropriate. It is important to explain that some regulations may be applicable or, if not applicable, may still be relevant and appropriate. When the analysis determines that a requirement is both relevant and appropriate, such a requirement must be complied with to the same degree as if it were applicable (U.S. EPA 1988a). Tables included in this appendix present each potential ARAR with an initial determination of ARAR status (i.e., applicable, relevant and appropriate, or not an ARAR). For the determination of relevance and appropriateness, the pertinent criteria were examined to determine whether the requirements addressed problems or situations sufficiently similar to the circumstances of the release or response action contemplated, and whether the requirement was well suited to the site. A negative determination of relevance and appropriateness indicates that the requirement did not meet the pertinent criteria. Negative determinations are documented in the tables of this appendix and are discussed in the text only for specific cases.

To qualify as a state ARAR under CERCLA and the NCP, a state requirement must be:

- a state law or regulation,
- an environmental or facility siting law or regulation,
- promulgated (of general applicability and legally enforceable),
- substantive (not procedural or administrative),
- more stringent than federal requirements,
- identified in a timely manner, and
- consistently applied.

To constitute an ARAR, a requirement must be substantive. Therefore, only the substantive provisions of requirements identified as ARARs in this analysis are considered to be ARARs. Permits are considered to be procedural or administrative requirements. Provisions of generally relevant federal and state statutes and regulations that were determined to be procedural or nonenvironmental, including permit requirements, are not considered to be ARARs. CERCLA Section 121(e)(1), 42 U.S.C. § 9621(e)(1), states that "No Federal, State, or local permit shall be required for the portion of any removal or remedial action conducted entirely on-site, where such remedial action is selected and carried out in compliance with this section." The term on-site is defined for purposes of this ARARs discussion as "the areal extent of contamination and all suitable areas in very close proximity to the contamination necessary for implementation of the response action" (40 C.F.R. § 300.5).

Nonpromulgated advisories or guidance issued by federal or state governments are not legally binding and do not have the status of ARARs. Such requirements may, however, be useful, and are "to be considered" (TBC). TBC (40 C.F.R. § 300.400[g][3]) requirements complement ARARs but

do not override them. They are useful for guiding decisions regarding cleanup levels or methodologies when regulatory standards are not available.

Pursuant to U.S. EPA guidance (U.S. EPA 1988a), ARARs are generally divided into three categories: chemical-specific, location-specific, and action-specific requirements. This classification was developed to aid in the identification of ARARs; some ARARs do not fall precisely into one group or another. ARARs are identified on a site basis for remedial actions where CERCLA authority is the basis for cleanup.

As the lead federal agency, the DON has primary responsibility for identifying federal ARARs at the former MCAS El Toro. Potential federal ARARs that have been identified for remediation of radium-226 (RA-226) contaminated soil at IRP Site 8, Units 1 and 4 are discussed in Section X1.2.2. Pursuant to the definition of the term on-site in 40 C.F.R. § 300.5, the on-station areas that are part of this action include Units 1 and 4 of Site 8 (areas with Ra-226 contaminated soil) and the areas in close proximity including Units 2, 3 and 5 of the site. The Ra-226 contaminated soil excavated from Units 1 and 4 of Site 8 will be temporarily stored at Unit 2 for treatment, radiological screening or off-site disposal. Off-site disposal of Ra-226, which is a component of some remedial action alternatives, is considered to be off-site action. Regulatory requirements that apply to off-site action are not ARARs. Off-site disposal is required to comply with applicable requirements only and is not required to comply with relevant and appropriate requirements identified as ARARs for on-site actions.

Identification of potential state ARARs was initiated through DON requests that the California Environmental Protection Agency (Cal/EPA) Department of Toxic Substances Control (DTSC) identify potential state ARARs, an action described in more detail in Section X1.2.3. Potential state ARARs that have been identified for remediation of Ra-226 contaminated soil at Units 1 and 4 of Site 8 are discussed below.

1.2 METHODOLOGY DESCRIPTION

The process of identifying and evaluating potential federal and state ARARs is described in this subsection.

1.2.1 General

As the lead federal agency, the DON has primary responsibility for identification of potential ARARs for Site 8. In preparing this ARARs analysis, the DON undertook the following measures, consistent with CERCLA and the NCP:

- identified federal ARARs for each remedial action alternative addressed in the FS Addendum, taking into account site-specific information for Site 8;
- reviewed potential state ARARs identified by the state to determine whether they satisfy CERCLA and NCP criteria that must be met in order to constitute state ARARs;
- evaluated and compared federal ARARs and their state counterparts to determine whether state ARARs are more stringent than the federal ARARs or are in addition to the federally required actions; and
- reached a conclusion as to which federal and state ARARs are the most stringent and/or "controlling" ARARs for each alternative.

As outlined in Section 3.2 of the FS report, the remedial action objectives (RAOs) for Units 1 and 4 of Site 8 are to:

- Reduce potential exposure to incremental concentrations (above naturally occurring background levels) of Ra-226 such that residual carcinogenic risk (above background) is in the NCP defined risk management range (10^{-6} to 10^{-4}).
- Reduce potential exposure to incremental concentrations (above naturally occurring background levels) of Ra-226 to achieve compliance with NRC standards for protection against radiation, specified in 10 C.F.R. Sections 20.1402 and 20.1403, such that the total effective dose equivalent (TEDE) (above background) does not exceed 25 mrem/y and that the residual radioactivity (due to Ra-226) has been reduced to levels that are as low as reasonably achievable (ALARA).

Remedial action alternatives retained for detailed analysis in this FS Addendum are designed to accomplish these RAOs and include the following:

- Alternative 1: No Action
- Alternative 2: Asphalt Cap Plus Institutional Controls and Access Restrictions
- Alternative 3: Excavation and Off-site Disposal

1.2.2 Identifying and Evaluating Federal ARARs

The DON is responsible for identifying federal ARARs as the lead federal agency under CERCLA and the NCP. The final determination of federal ARARs will be made when the DON issues the ROD/AM. The federal government implements a number of federal environmental statutes that are the source of potential federal ARARs, either in the form of the statutes or regulations promulgated thereunder. Examples include the Resource Conservation and Recovery Act (RCRA), the Clean Water Act, the Safe Drinking Water Act, the Toxic Substances Control Act, and their implementing regulations, to name a few. See NCP preamble at 55 Federal Register (Fed. Reg.) 8764–8765 (1990) for a more complete listing.

The proposed remedial action and alternatives were reviewed against all potential federal ARARs, including but not limited to those set forth at 55 Fed. Reg. 8764–8765 (1990), in order to determine if they were applicable or relevant and appropriate utilizing the CERCLA and NCP criteria and procedures for ARARs identification by lead federal agencies.

1.2.3 Identifying and Evaluating State ARARs

The process of identifying and evaluating potential state ARARs by the state and the DON is described in this subsection.

1.2.3.1 Solicitation of State ARARs Under NCP

U.S. EPA guidance (U.S. EPA 1988b) recommends that the lead federal agency consult with the state when identifying state ARARs for remedial actions. In essence, the CERCLA/NCP requirements at 40 C.F.R. § 300.515 for remedial actions provide that the lead federal agency request that the state identify chemical- and location-specific state ARARs upon completion of site characterization. The requirements also provide that the lead federal agency request identification of all categories of state ARARs (chemical-, location-, and action-specific) upon completion of identification of remedial alternatives for detailed analysis. The state must respond within 30 days of receipt of the lead federal agency requests. The remainder of this subsection documents the DON's efforts to date to identify and evaluate state ARARs.

The DON followed the procedures of the process set forth in 40 C.F.R. § 300.515 and Section 7.6 of the Federal Facilities Agreement (FFA) for remedial actions in seeking state assistance in identifying state ARARs.

1.2.3.2 CHRONOLOGY OF EFFORTS TO IDENTIFY STATE ARARS

The following chronology summarizes the DON efforts to obtain state assistance in identifying state ARARs for the remedial action for Ra-226 at Units 1 and 4 of Site 8. Key correspondence between the DON and the state agencies relating to this effort has been included in the Administrative Record (AR) for this FS Addendum.

The DON initiated the ARARs identification process at Site 8 with a letter (dated 25 April 1997) to the DTSC, requesting input on identification of chemical-, location-, and action-specific state ARARs. The responses to the DTSC request were transmitted to the DON as enclosures with a letter dated 27 May 1997. Enclosed with this letter, the DON received input from the following agencies:

- California Regional Water Quality Control Board (RWQCB), Santa Ana Region (letter dated 06 May 1997);
- California EPA, Integrated Waste Management Board (letter dated 23 May 1997);
- California EPA, Air Resources Board (letter dated 12 May 1997); and
- SCAQMD (letter dated 20 May 1997).

The DON reviewed and evaluated all ARARs submitted by the agencies noted above during the preparation of FS report for Site 8. However, subsequent to the preparation of the FS (BNI 1997) and Draft ROD (DON 1999), Ra-226 was identified at Site 8. Therefore, DON formally requested state ARARs for radiological component of response action at Site 8 (along with Site 12) on 27 May 2004. Letters were sent to the DTSC and RWQCB soliciting ARARs based on the previous investigation results summary and removal/remedial action alternatives. Following the DON solicitation for ARARs from DTSC, DTSC requested ARARs from other state and local agencies.

The DON received a letter from RWQCB providing its ARARs on 30 June 2004. The list of potential ARARs included chemical- and action-specific ARARs that the RWQCB believes are applicable. All the potential ARARs are listed in the tables in this appendix.

The DON received a letter from DTSC providing a list of potential state chemical-, location-, and action-specific ARARs on 30 June 2004. The list included responses from the following agencies:

- California DHS (letter dated 3 June 2004);
- California Department of Fish and Game (letter dated 16 June 2004);
- California EPA, Air Resources Board (letter dated 18 June 2004);
- SCAQMD (letter dated 18 June 2004); and
- California Department of Transportation (letter dated 22 June 2004).

1.3 OTHER GENERAL ISSUES

General issues identified during the evaluation of ARARs for Site 8, Units 1 and 4 are discussed in the following subsections.

Under Cal. Code Regs. tit. 27, § 20230, inert waste is that subset of solid waste that does not contain hazardous waste or soluble pollutants at concentrations in excess of applicable water quality objectives and does not contain significant quantities of decomposable waste.

The TCLP test and WET will most likely demonstrate that soil at Units 1 and 4 of Site 8 does not exhibit the characteristics of RCRA or California-regulated, non-RCRA hazardous waste. In this case, the soil at Units 1 and 4 will be classified as designated, nonhazardous, or inert waste depending upon the concentrations of COPCs in the soil.

1.4.4 Radiological Waste Classification

In accordance with EPA guidance, *Radioactive Waste Disposal. An Environmental Perspective*, there are five general categories of radioactive wastes: (1) spent nuclear fuel from nuclear reactors and high-level waste from the reprocessing of spent nuclear fuel (2) transuranic waste (3) uranium mill tailings or by product material (4) low-level waste, and (5) naturally occurring and accelerator-produced radioactive materials (NARM).

The legal definitions of spent nuclear fuel and high-level waste provided at 42 U.S.C. § 10101. In accordance with 42 U.S.C. § 10101, the "high-level radioactive waste" means:

1. the highly radioactive material resulting from the reprocessing of spent nuclear fuel, including liquid waste produced directly in reprocessing and any solid material derived from such liquid waste that contains fission products in sufficient concentrations; and
2. other highly radioactive material that the Commission, consistent with existing law, determines by rule requires permanent isolation.

The 42 U.S.C. § 10101 defines "spent nuclear fuel" as the fuel that has been withdrawn from a nuclear reactor following irradiation, the constituent elements of which have not been separated by reprocessing.

The definition of Low Level Radioactive Waste (LLW) at 10 C.F.R § 61.2 defines it as radioactive waste which contains source, special nuclear, or byproduct material, and which is not classified as high-level radioactive waste, transuranic waste, spent nuclear fuel, or byproduct material. This definition refers to the Atomic Energy Act (AEA), Section 11(e)(2) which contains the following definitions:

> (e) The term "byproduct material" means
>
> (1) any radioactive material (except special nuclear material) yielded in or made radioactive by exposure to the radiation incident to the process of producing or utilizing special nuclear material, and
>
> (2) the tailings or wastes produced by the extraction or concentration of uranium or thorium from any ore processed primarily for its source material content.
>
> (z) The term "source material" means
>
> (1) uranium, thorium, or any other material which is determined by the Commission pursuant to the provisions of section 2091 of this title to be source material; or
>
> (2) ores containing one or more of the foregoing materials, in such concentration as the Commission may by regulation determine from time to time.
>
> (aa) The term "special nuclear material" means (1) plutonium, uranium enriched in the isotope 233 or in the isotope 235, and any other material which the Commission, pursuant to the provisions of section 2071 of this

> title, determines to be special nuclear material, but does not include source material; or (2) any material artificially enriched by any of the foregoing, but does not include source material.
>
> (ee) The term "transuranic waste" means material contaminated with elements that have an atomic number greater than 92, including neptunium, plutonium, americium, and curium, and that are in concentrations greater than 10 nanocuries per gram, or in such other concentrations as the Nuclear Regulatory Commission may prescribe to protect the public health and safety.

NARM is a broad category that includes accelerator-produced radioactive material and naturally occurring radioactive material (NORM) (e.g. Ra-226), excluding source, special nuclear, or by-product material. NARM are not regulated under the AEA or any other Federal regulation. In California, the NORM are regulated by the DHS.

Radium-226 (Ra-226) is the radiological COPC at Units 1 and 4 of Site 8. Potential sources of Ra-226 at Units 1 and 4 are from storage of Ra-226 painted parts, gauges, dials, and markers. The soil mixed with equipment or components containing Ra-226 at Units 1 and 4 of Site 8 appears to meet the definition of NARM.

Since the Ra-226 contaminated soil is similar to LLW, the NRC Licensing Requirements for Land Disposal of Radioactive Waste (10 C.F.R. Part 61, Subparts H and I) were evaluated to determine if they are potential ARARs for remediation of Ra-226 contaminated soil. NRC Licensing Requirements for Land Disposal of Radioactive Waste (10 C.F.R. Part 61, Subparts H and I) are not potentially applicable since the site is not a NRC licensed site. However, the performance objectives for the land disposal of LLW may be relevant and appropriate. These requirements in 10 C.F.R. § 61.41 require that concentrations of radioactive material that may be released to the general environment must not result in an annual dose exceeding 25 mrem to the body or any organ of a member of the general public. These requirements are potentially relevant and appropriate for Site 8, Units 1 and 4 if the Ra-226 contaminated soil is left in-place.

2. CHEMICAL-SPECIFIC ARARS

Chemical-specific ARARs are generally health- or risk-based numerical values or methodologies applied to site-specific conditions that result in the establishment of a cleanup level. Many potential ARARs associated with particular response alternatives (such as closure or discharge) can be characterized as action-specific but include numerical values or methodologies to establish them so they fit in both categories (chemical- and action-specific). To simplify the comparison of numerical values, most action-specific requirements that include numerical values are included in this chemical-specific section and, if repeated in the action-specific section, the discussion refers back to this section.

This section presents ARARs determination conclusions addressing numerical values for shallow surface soil and a summary of the ARARs conclusions and a more detailed discussion of the ARARs for shallow surface soil.

Potential federal and state chemical-specific ARARs are summarized in Tables C-1 and C-2, respectively, which are at the end of this appendix.

2.1 SUMMARY OF ARARS CONCLUSIONS BY MEDIUM

Soil and air are the environmental media potentially affected by the remedial action at Site 8, Units 1 and 4. The conclusions for ARARs pertaining to these media are presented in the following sections.

2.1.1 Soil ARARs Conclusions

Analytical results from previous sampling events at Site 8, Units 1 and 4 indicate that a portion of the contaminated soil has the potential to exceed the toxicity characteristic for some metals and thus will have to be tested to evaluate if it is RCRA or California-regulated, non-RCRA hazardous waste. Therefore, the RCRA waste definition requirements at Cal. Code Regs. tit. 22, § 66261.21, 66261.22(a)(1), 66261.23, 66261.24(a)(1), and 66261.100 are potential federal ARARs for evaluating if the contaminated soil exhibits the characteristics of RCRA hazardous waste. Additionally, the non-RCRA, state-regulated waste definition requirements at Cal. Code Regs. tit. 22, § 66261.24(a)(2) are potential state ARARs for evaluating if the contaminated soil exhibits the characteristics of California-regulated, non-RCRA hazardous waste.

Since remedial action at Site 8, Units 1 and 4 will be conducted to address Ra-226, which is radioactive in nature, the Nuclear Regulatory Commission (NRC) requirements for license termination under unrestricted (10 C.F.R. § 20.1402) or restricted (10 C.F.R. § 20.1403 [a] and [b]) conditions are relevant and appropriate.

2.1.2 Air ARARs Conclusions

Capping, excavation, grading, and earthmoving activities, which are a part of remedial action alternatives for Ra-226 contaminated soil at Site 8, Units 1 and 4, may generate fugitive dust and radon gas emissions. Additionally, the equipment used for implementation of remedial action may lead to emissions of air pollutants. These air emissions are subjected to the requirements of South Coast Air Quality Management District (SCAQMD) regulations. The SCAQMD rules that have been approved by U.S. EPA as a part of state implementation plan (SIP) and were identified as potential federal ARARs for air emissions included, Rules 403, 404, and 405, 407, 409, 474, 1166, and Regulation XIII. Other SCAQMD rules that were identified as potential state ARARs included, Rules 401, 402, 408, 431.1, 431.2, 431.3; Regulation X; Regulation XI, Rule 1150; and Regulation XIV, Rule 1401. The ARAR evaluation of these rules indicated that substantive requirements of Rules 401, 403, 404, and 405 are potentially applicable to capping, excavation, grading, and earthmoving activities. These rules are discussed in more detail in action-specific requirements.

2.1.3 Soil ARARs

The key threshold question for soil ARARs is whether or not the wastes located at Units 1 and 4 of Site 8 would be classified as hazardous waste. The soil may be classified as a federal hazardous waste as defined by RCRA and the state-authorized program, or as non-RCRA, state-regulated hazardous waste. If the soil is determined to be hazardous waste, the appropriate requirements will apply.

2.1.3.1 FEDERAL

RCRA Hazardous Waste and Groundwater Protection Standards

The federal RCRA requirements at 40 C.F.R. pt. 261 do not apply in California because the state RCRA program is authorized. The authorized state RCRA requirements are therefore considered potential federal ARARs (see Section 1.3.1). The applicability of RCRA requirements depends on whether the waste is a RCRA hazardous waste, whether the waste was initially treated, stored, or disposed after the effective date of the particular RCRA requirement, and whether the activity at the site constitutes treatment, storage, or disposal as defined by RCRA. However, RCRA requirements may be relevant and appropriate even if they are not applicable. Examples include activities that are similar to the definition of RCRA treatment, storage, or disposal for waste that is similar to RCRA hazardous waste.

The determination of whether a waste is a RCRA hazardous waste can be made by comparing the site waste to the definition of RCRA hazardous waste. The RCRA requirements at Cal. Code Regs. tit. 22, § 66261.21, 66261.22(a)(1), 66261.23, 66261.24(a)(1), and 66261.100 are potential ARARs because they define RCRA hazardous waste. A waste can meet the definition of hazardous waste if it has the toxicity characteristic of hazardous waste. This determination is made by using the toxicity characteristic leaching procedure (TCLP). The maximum concentrations allowable for the TCLP listed in § 66261.24(a)(1)(B) are potential federal ARARs for determining whether the site has hazardous waste. If the site waste has concentrations exceeding these values, it is determined to be a characteristic RCRA hazardous waste (see Section 1.4.1).

As discussed in Section 1.4.1, sampling and TCLP testing will be conducted to evaluate if the soil at Units 1 and 4 of Site 8 may be classified as RCRA hazardous waste. If this sampling demonstrates that soil at Units 1 and 4 exhibits the characteristics of RCRA hazardous waste, then the federal RCRA regulations will be potential ARARs.

Groundwater is not the medium of potential concern at Site 8, Units 1 and 4, since the release of Ra-226 is likely to be restricted to shallow soil. No releases to groundwater have been detected and none are anticipated because of the immobile nature of Ra-226. Therefore, Site 8 does not pose a current threat to groundwater. However, since the intent of Site 8 response action is soil remediation with no further responses, vadose zone requirements have been evaluated as potential ARARs for threats to water quality potentially caused by soil contamination. The DON has determined that the substantive provisions of Cal. Code Regs. tit. 22, § 66264.94(a)(1), (a)(3), (c), (d), and (e) are potential federal ARARs for the vadose zone. Since Ra-226 is relatively immobile and is likely restricted to the shallow soil, and Ra-226 vadose zone standards will be met with remedial alternatives considered, this ARAR is met.

RCRA land disposal restrictions (LDRs) at Cal. Code Regs. tit. 22, § 66268.1(f) are triggered if the hazardous are discharged to land. During remedial action at Site 8, it is not anticipated that any RCRA hazardous wastes generated will be placed outside the area of contamination. Therefore, LDRs are not ARARs.

NRC Standards for Protection of Radiation

The radiological criteria for license termination under the Nuclear Regulatory Commission (NRC) include requirements that may be pertinent to DON sites. These requirements have been discussed in EPA guidance (EPA 1997, OSWER Directive 9200.4-18).

The radiological criteria for termination of a license for an existing NRC-licensed, radiologically-contaminated site for future unrestricted use are found at 10 C.F.R. 20 § 1402. It states that a site will be considered acceptable for unrestricted use if the residual radioactivity that is distinguishable from background radiation results in a Total Effective Dose Equivalent (TEDE) to an average member of the critical group that does not exceed 25 mrem (0.25 mSv) per year, including that from groundwater sources of drinking water, and that the residual radioactivity has been reduced to levels that are As Low As Reasonably Achievable (ALARA). TEDE means the sum of the deep-dose equivalent (for external exposures) and the committed effective dose equivalent (for internal exposures).

Site 8 is not a NRC-licensed radiologically-contaminated site. In addition, Ra-226 is not a NRC-regulated material. Therefore, the requirements of radiological criteria for license termination at 10 C.F.R. 20 § 1402 are not applicable. However, these requirements are potentially relevant and appropriate if unrestricted reuse is proposed following remedial action, since Units 1 and 4 of Site 8 have contaminants similar to those regulated at an NRC-licensed site, i.e. Ra-226.

The radiological criteria for termination of a license for an existing NRC-licensed, radiologically-contaminated site for future restricted use are found at 10 C.F.R. § 20.1403(a) and (b). Since Site 8 is not a NRC-licensed radiologically-contaminated site, these requirements are not applicable. However, these requirements are potentially relevant and appropriate if restricted reuse is proposed following remedial action, since Units 1 and 4 of Site 8 have contaminants similar to those regulated at an NRC-licensed site (i.e., Ra-226).

The alternative criteria for license termination that is greater than dose criteria specified in 10 C.F.R. 20 § 1402 and 10 C.F.R. § 20.1403(a) and (b) is presented in 10 C.F.R. § 20. 1404(a)(1), (2), and (3). These requirements are not applicable to Site 8, Units 1 and 4 because Site 8 is not a NRC-licensed site. These requirements are potentially relevant and appropriate if restricted reuse is proposed following remedial action, since Units 1 and 4 of Site 8 have contaminants similar to those regulated at an NRC-licensed site (i.e., Ra-226).

Uranium Mill Tailings Radiation Control Act

Standards for the cleanup of certain radiologically-contaminated sites have been issued under the Uranium Mill Tailings Radiation Control Act (UMTRCA), P.L. 95-604. These standards are codified at 40 C.F.R Part 192 and were developed specifically for the cleanup of uranium mill tailings at 24 sites designated under § 102(a)(1) of UMTRCA (Title I sites). The purpose of these standards was to limit the risk from inhalation of radon decay products in houses built on land contaminated with tailings, and to limit gamma radiation exposure of people using contaminated land (see 48 FR 600). The UMTRCA standards are not applicable to Site 8 because it is not a mill site to which the UMTRCA standards specifically apply. Specific UMTRCA requirements are therefore evaluated as to whether they are potentially relevant and appropriate for the remedial action at Site 8.

In order for standards at 40 C.F.R. Part 192 to be potentially relevant and appropriate, the contaminants at the site must be the same (i.e , radium –226, radium-228, and/or thorium) and the distribution of contamination must be similar to the that existing at a Title I site (U.S. EPA, 1998x, Directive No. 9200.4-25). If it is determined that either in the course of further study or even during

remedial action that subsurface contamination exists at a level between 5pCi/g to 15 pCi/g averaged over areas of 100 square meters (the averaging areas provided for in Part 192 rules), this indicates that conditions at the site are probably not sufficiently similar to a UMTRCA site to consider the subsurface standard at 40 C.F.R. 192 relevant and appropriate. If contamination at the site is unlike that of uranium mill tailings sites, in that significant subsurface contamination exists at a level between 5 pCi/g and 30 pCi/g, the use of 15 pCi/g standard is not generally appropriate. Instead, 5 pCi/g is recommended since that was the actual health-based standard expected to be achieved by 40 C.F.R. 192. Where these standards are identified as ARARs for radium-226 and radium-228, they should also be applied to parents of these, thorium-230 and thorium-228.

UMTRCA standards for the control of residual radiological materials from inactive uranium processing sites are found at 40 C.F.R §192.02(b), which provides criteria for releases of radon-222 from residual radiological material to the atmosphere as follows:

"Provide reasonable assurance that releases of radon-222 from residual radioactive material to the atmosphere will not:

(1) Exceed an average release rate of 20 picocuries per square meter per second. This average shall apply over the entire surface of the disposal site and over at least a one-year period. Radon will come from both residual radioactive materials and from materials covering them. Radon emissions from the covering materials should be estimated as part of developing a remedial action plan for each site. The standard, however, applies only to emissions from residual radioactive materials to the atmosphere. Or,

(2) Increase the annual average concentration of radon-222 in air at or above any location outside the disposal site by more than one-half picocurie per liter."

It is highly unlikely that releases of radon-222 at Site 8 following remedial action would exceed the threshold criteria in 40 C.F.R §192.02(b). Therefore, this requirement is not a potential ARAR.

Requirements for cleanup of radiological contaminants are found in UMTRCA standards for cleanup of land and buildings contaminated with residual radiological materials from inactive uranium processing sites. Dose limits for radium-226 in soil are found at 40 C.F.R §192.12(a), §192.32(b)(2) and §192.41 which states that as a result of residual radiological materials from any designated processing site:

(a) The concentration of radium-226 in land averaged over any area of 100 square meters shall not exceed the background level by more than,

(1) 5 pCi/g, averaged over the first 15 cm of soil below the surface, and

(2) 15 pCi/g, averaged over 15 cm thick layers of soil more than 15 cm below the surface.

The substantive provisions of 40 C.F.R §192.12(a), §192.32(b)(2) and §192.41 have been determined to be potentially relevant and appropriate for Site 8, Units 1 and 4 since the contaminant (Ra-226) matches and subsurface contamination is expected at level between 5 to 30 pCi/g in the subsurface.

The requirements at 40 C.F.R § 192.12(b)(1) and § 192.41(b) state that in any occupied or habitable building the objective of remedial action shall be, and reasonable effort shall be made to achieve, an annual average (or equivalent) radon decay product concentration (including background) not to exceed 0.02 Working Level (WL). In any case, the radon decay product concentration (including

background) shall not exceed 0.03 WL. Provisions applicable to radon-222 shall also apply to radon-220. The provisions of 40 C.F.R § 192.12(b)(1) and § 192.41(b) are potentially relevant and appropriate if habitable buildings are constructed at Units 1 and 4 of Site 8 as a part of site reuse.

For concentration limits for cleanup of gamma radiation in buildings at inactive uranium processing sites designated for remedial action, 40 C.F.R. § 192.12(b)(2) requires that in any occupied or habitable building, the level of gamma radiation shall not exceed the background level by more than 20 microroentgens per hour. The provisions of 40 C.F.R § 192.12(b)(2) are potentially relevant and appropriate if habitable buildings are constructed at Units 1 and 4 of Site 8 as a part of site reuse.

2.1.3.2 STATE

RCRA Requirements

State RCRA requirements included within the U.S. EPA-authorized RCRA program for California are considered to be potential federal ARARs and are discussed above. When state regulations are either broader in scope or more stringent than their federal counterparts, they are considered potential state ARARs. State requirements such as the non-RCRA, state-regulated hazardous waste requirements may be potential state ARARs because they are not within the scope of the federal ARARs (57 Fed. Reg. 60848). The Cal. Code Regs. tit. 22, div. 4.5 requirements that are part of the state-approved RCRA program would be potential state ARARs for non-RCRA, state-regulated hazardous wastes.

The site waste characteristics need to be compared to the definition of non-RCRA, state-regulated hazardous waste. The non-RCRA, state-regulated waste definition requirements at Cal. Code Regs. tit. 22, § 66261.24(a)(2) are potential state ARARs for determining whether other RCRA requirements are potential state ARARs. This section lists the total threshold limit concentrations (TTLCs) and soluble threshold limit concentration (STLCs). The site waste may be compared to these thresholds to determine whether it meets the characteristics for a non-RCRA, state-regulated hazardous waste.

As discussed in Section 1.4.2, sampling will be conducted to evaluate if the soil at Units 1 and 4 of Site 8 may be classified as California-regulated, non-RCRA hazardous waste. If this sampling demonstrates that soil at Units 1 and 4 exhibits the characteristics of California-regulated, non-RCRA hazardous waste, then the state RCRA regulations will be potential ARARs.

Cal. Code Regs. tit. 27, div. 2, subdiv. 1

Former Cal. Code Regs. tit. 23, div. 3, ch. 15 requirements that have been repealed and went into effect on 18 July 1997, the following sections define waste characteristics for discharge of waste to land. These requirements may be applicable for soil left in place that was discharged after the effective date of the requirements. They are not potentially applicable to discharges before that date but may be relevant and appropriate.

Cal. Code Regs. tit. 27, § 20230(a) defines inert waste as waste "that does not contain hazardous waste or soluble pollutants at concentrations in excess of applicable water quality objectives, and does not contain significant quantities of decomposable waste." Cal. Code Regs. tit. 27, § 20230(b) states that "inert wastes do not need to be discharged at classified waste management units." Cal. Code Regs. tit. 27, § 20230(a) and (b) may be potential state ARARs for soil that meets the definition of inert waste.

Cal. Code Regs. tit. 27, §§ 20210 and 20220 are state definitions for designated waste and nonhazardous waste, respectively. These may be ARARs for soil that meets the definitions. These

soil classifications determine state classification and siting requirements for discharging waste to land.

The DON has reviewed the provisions of Cal. Code Regs. tit. 27, §§ 20380(a) and 20400(a), (c), (d), (e), and (g), and 20405. These sections address the concentration limits and POC for monitoring at waste management units for other than hazardous wastes. The DON has determined that these provisions are identical to those found in Cal. Code Regs. tit. 22, §§ 66264.94(d)(1), (2), and (4), and (e)(1) and (2) and 66264.95. The requirements at Cal. Code Regs. tit. 27, §§ 20380(a), 20400(a), (c), (d), (e) and (g), and 20405 are therefore not ARARs because they are not more stringent than federal ARARs at Cal. Code Regs. tit. 22, § 66264.94(d)(1), (2), and (4), and (e)(1) and (2) and Cal. Code Regs. tit. 22, § 66264.95.

Radiological ARARs

The DHS identified the Cal. Code Regs., tit. 17 as potential ARARs for remedial action at Site 8. The requirements at Cal Code regs. tit. 17 are not potentially applicable since they apply to radiological materials under a license. However, they were evaluated further as potentially relevant and appropriate requirements. The standards at Cal. Code Regs. tit. 17, Section 30253(a) incorporate by reference the federal standards at 10 CFR Part 20. Since they are not more stringent than federal requirements, they are not potential ARARs.

2.1.4 Air ARARs

Capping, excavation, grading, and earthmoving activities, which are a part of remedial action alternatives for Ra-226 contaminated soil at Site 8, Units 1 and 4, may generate fugitive dust and radon gas emissions. Additionally, the equipment used for implementation of remedial action may lead to emissions of air pollutants. These emissions are subjected to the requirements of SCAQMD rules, which are potential ARARs for the remedial action at Site 8, Units 1 and 4. ARARs for air are discussed in greater detail under action-specific requirements.

2.1.4.1 FEDERAL

The CAA and RCRA air emission requirements are discussed below.

Clean Air Act

The CAA establishes the National Ambient Air Quality Standards (NAAQS) in 40 C.F.R. § 50.4–50.12. NAAQS are not enforceable in and of themselves; they are translated into source-specific emissions limitations by the state (U.S. EPA 1990). Substantive requirements of the SCAQMD rules that have been approved by U.S. EPA as part of the SIP under the CAA are potential federal ARARs for air emissions (CAA Section 110). The SIP includes rules for emissions restrictions for particulates, organic compounds, and hazardous air pollutants, as well as standards of performance for new sources.

SCAQMD rules that have been approved by U.S. EPA as a part of SIP and were identified as potential federal ARARs for air emissions included, Rules 403, 404, 405, 407, 409, 474, 1166, and Regulation XIII. The ARAR evaluation of these rules indicated that substantive provisions of Rules 403, 404, and 405 are potentially applicable to capping, excavation, grading, and earthmoving activities. These rules are discussed in more detail in action-specific requirements.

RCRA Air Emission Requirements

RCRA air emissions standards at Cal. Code Regs. tit. 22, § 66264.1030–66264.1034, excluding .1030(c), .1033(j), .1034(c)(2), and .1034(d)(2), and at Cal. Code Regs. tit. 22, § 66264.1050–

66264.1063, excluding .1050(c) and (d), .1057(g)(2), .1060, .1063(d)(3), for vents or equipment leaks pertain to equipment that contains or contacts hazardous wastes with organic concentrations of at least 10 percent by weight. These standards are not ARARs as organic concentrations are not expected to exceed 10 percent by weight at Site 8, Units 1 and 4.

2.1.4.2 STATE

SCAQMD Rules 401, 402, 408, 431.1, 431.2, 431.3; Regulation X; Regulation XI, Rule 1150; and Regulation XIV, Rule 1401 were identified as potential state ARARs for the air emissions at Site 8, Units 1 and 4. The ARAR evaluation of these rules indicated that substantive provisions of Rule 401 are potentially applicable to capping, excavation, grading, and earthmoving activities. These rules are discussed in more detail in the action specific ARARs.

3. LOCATION SPECIFIC ARARS

Potential location-specific ARARs are identified and discussed in this section. The discussions are presented based on various attributes of the site location, such as whether it is within a floodplain. Additional surveys will be performed in connection with the remedial action design and remedial action to confirm location-specific ARARs where inadequate siting information currently exists, or in the event of changes to planned facility locations.

3.1 SUMMARY OF LOCATION SPECIFIC ARARS

The only resource category potentially affected by the remedial action at Site 8, Units 1 and 4 is that of biological resources. No federal locations-specific ARARs have been identified for remedial action at Site 8. The state ARARs pertaining to protection of biological resources for remedial action at Site 8, Units 1 and 4 include:

- Cal. Fish and Game Code §§ 5650 (a), (b), & (f); 3005; 3503; 3503.5; 3800; and 4150
- Cal. Code Regs. tit. 14 § 472

These ARARs are discussed in more detail in the action-specific requirements.

3.2 DETAILED DISCUSSION OF ARARS

The following subsections provide a detailed discussion of federal and state ARARs by location-specific resources. Pertinent and substantive provisions of the potential ARARs listed and described below were reviewed to determine whether they are potential federal or state ARARs for the Site 8, Units 1 and 4, soil FS.

3.2.1 Cultural Resources ARARs

No surficial evidence of significant cultural resources have been identified at Site 8 in existing data that could be potentially impacted by the remedial action. Therefore, no location-specific ARARs pertaining to preservation of cultural resources have been identified for Site 8.

3.2.2 Wetlands Protection and Floodplains Management ARARs

Site 8 does not fall within the floodplain and does not contain wetlands. Additionally, there will be no dewatering or discharges of effluents under the remedial alternatives. Therefore, no ARARs were identified for wetlands protection and floodplains management.

3.2.3 Hydrologic Resources ARARs

None of the remedial action alternatives for Site 8, Units 1 and 4 include modification of the natural stream or water body. Therefore, no location-specific ARARs pertaining to hydrologic resources have been identified for Site 8.

3.2.4 Biological Resources ARARs

3.2.4.1 FEDERAL

Endangered Species Act of 1973

The Endangered Species Act (ESA) of 1973 (16 U.S.C. §§ 1531–1543) provides a means for conserving various species of fish, wildlife, and plants that are threatened with extinction. The ESA defines an endangered species and provides for the designation of critical habitats. Federal agencies may not jeopardize the continued existence of any listed species or cause the destruction or adverse modification of critical habitat. Under Section 7(a) of the ESA, federal agencies must carry out

conservation programs for listed species. The Endangered Species Committee may grant an exemption for agency action if reasonable mitigation and enhancement measures such as propagation, transplantation, and habitat acquisition and improvement are implemented. Consultation regulations at 50 C.F.R. § 402 are administrative in nature and are therefore not ARARs. However, they may be TBCs to comply with the substantive provisions of the ESA.

A habitat assessment was included as Appendix L in the remedial investigation report (Bechtel 1997b) of Site 8. The assessment did not find any special status species habitat or observed any special status species at Site 8. The Endangered Species Act of 1973 is not an ARAR.

Migratory Bird Treaty Act of 1972

The Migratory Bird Treaty Act (16 U.S.C. §§ 703–712) prohibits at any time, using any means or manner, the pursuit, hunting, capturing, and killing or attempting to take, capture, or kill any migratory bird. This act also prohibits the possession, sale, export, and import of any migratory bird or any part of a migratory bird, as well as nests and eggs. A list of migratory birds for which this requirement applies is found at 50 C.F.R. § 10.13. It is the DON's position that this act is not legally applicable to DON actions; however, Exec. Order No. 13186 (dated 10 January 2001) requires each federal agency taking actions that have or are likely to have a measurable effect on migratory bird populations to develop and implement, within 2 years, a memorandum of understanding (MOU) with the United States Fish and Wildlife Service (USFWS) to promote the conservation of such populations. The DoD and the USFWS are in the process of negotiating this MOU. In the meantime, the Migratory Bird Treaty Act will continue to be evaluated as a potentially relevant and appropriate requirement for DON CERCLA response actions.

No migratory birds have been observed at Site 8, therefore Migratory Bird Treaty Act of 1972 is not a potential ARAR.

3.2.4.2 *STATE*

California Department of Fish and Game identified the following requirements as potential ARARs pertaining to biological resources for the remedial action at Site 8, Units 1 and 4.

- Cal. Fish and Game Code §§ 1908, 2080, 5650, 3005, 2008, 3003.1, 3551, 4700, 5050, 3503, 3503.5, 3800, 4000 – 4012, 4750, 4800 – 4809, and 5515
- Cal. Fish and Game Commission Wetlands Policy
- Cal. Code Regs. tit. 14 §§ 40, 460, 465, 472, and 475

The ARAR analysis of the above-mentioned regulations indicated that following ARARs are potentially relevant and appropriate to remedial action at Site 8, Units 1 and 4:

- Cal. Fish and Game Code §§ 5650 (a), (b), & (f); 3005; 3503; 3503.5; 3800; and 4150
- Cal. Code Regs. tit. 14 § 472

These ARARs are discussed in more detail in the action-specific requirements.

3.2.5 Coastal Resources ARARs

Site 8 is not located within a coastal zone and remedial action at the site will not impact coastal areas. Therefore, no location-specific ARARs pertaining to coastal resources have been identified for Site 8.

4. ACTION-SPECIFIC ARARS

This FS Addendum evaluated remedial action alternatives for Ra-226 contaminated soil at Units 1 and 4 of Site 8. The action-specific ARARs analysis is based on the three remedial action alternatives for the site. Alternative 1 is no action; Alternative 2 entails capping, institutional controls and access restrictions; and Alternative 3 entails excavation and off-site disposal. Detailed descriptions of the remedial action alternatives are provided in the main text of this FS Addendum.

Tables C-3 and C-4 at the end of this section present and evaluate federal and state potential action-specific ARARs for Site 8, Units 1 and 4 respectively. A discussion of the requirements determined to be pertinent to each alternative being evaluated for Site 8 remedial action is presented in this section. A discussion of how the alternative complies with each identified ARAR is also provided.

4.1 ALTERNATIVE 1 – NO ACTION

The inclusion of the no-action alternative is required under the NCP (40 C.F.R. § 300.430 [e][6]) to act as a baseline condition for assessing other alternatives in the FS. Under the no-action alternative, none of the GRAs including institutional controls/access restrictions, containment, immobilization, removal, volume reduction, or disposal would be implemented at Units 1 and 4 of Site 8.

There is no need to identify ARARs for the no action alternative because ARARs apply to "any removal or remedial action conducted entirely on-site" and "no action" is not a removal or remedial action (CERCLA Section 121(e), 42 U.S.C. § 9621[e]). CERCLA Section 121 (42 U.S.C. § 9621) cleanup standards for selection of a Superfund remedy, including the requirement to meet ARARs, are not triggered by the no action alternative (U.S. EPA 1991b). Therefore, a discussion of compliance with action-specific ARARs is not appropriate for this alternative.

4.2 ALTERNATIVE 2 - ASPHALT CAP PLUS INSTITUTIONAL CONTROLS AND ACCESS RESTRICTIONS

Alternative 2 includes construction of an asphalt cap in the central and northeastern parts of Unit 1 to reduce exposure to Ra-226 contaminated soil. Institutional controls consisting of land-use restrictions will also be implemented to ensure the integrity of the cap and limit exposure to future landowner(s) and/or user(s).

4.2.1 Federal ARARs

4.2.1.1 SCAQMD REQUIREMENTS

Capping will involve compaction of the subgrade, construction of a cap and use of heavy equipment. These activities may lead to fugitive dust or other air emissions and would need to comply with the substantive requirements of the SCAQMD rules. The SCAQMD rules that have been approved by U.S. EPA as a part of SIP and were identified as potential federal ARARs for air emissions included, Rules 403, 404, 405, 407, 409, 474, 1166, and Regulation XIII. The ARAR evaluation of these rules indicated that substantive requirements of Rules 403, 404, and 405 are potentially applicable to capping at Site 8. The details of these rules and methods of compliance for each are presented in the following sections.

Rule 403

This rule prohibits emissions of fugitive dust such that the presence of such dust remains visible in the atmosphere beyond the property line of the emission source and shall not cause or allow PM_{10} levels to exceed 50 micrograms per cubic meter when determined, by simultaneous sampling, as the difference between upwind and downwind samples

Cap construction activities may generate fugitive dust emissions. Measures such as applying water to prevent fugitive dust emissions will be implemented.

Rule 404

This rule limits equipment from discharging particulate emissions in excess of 0.01 to 0.196 grain per cubic foot based on a given volumetric (dry standard cubic feet per minute) exhaust gas flow rate averaged over one hour or on cycle of operation. It excludes steam generators or gas turbines.

The equipment used during remedial action will comply with substantive requirements of this rule.

Rule 405

This rule limits equipment from discharging particulate emissions in excess of 0.99 to 30 pounds per hour based on a given process weight.

The equipment used during remedial action will comply with substantive requirements of this rule.

4.2.2 State ARARs

4.2.2.1 SCAQMD Requirements

SCAQMD Rules 401, 402, 408, 431.1, 431.2, and 431.3; Regulation X; Regulation XI, Rule 1150; and Regulation XIV, Rule 1401 were identified as potential state ARARs for the air emissions at Site 8, Units 1 and 4. The ARAR evaluation of these rules indicated that substantive requirements of Rule 401 are potentially applicable to capping at Site 8. The following section presents summary of Rule 401 and proposed method of compliance during cap construction activities.

Rule 401

This rule prohibits the discharge of any air contaminant into the atmosphere from any single source of emission for a period or periods aggregating more than 3 minutes in a 60-minute period, which is (a) as dark or darker in shade as that designated No. 1 on the Ringelmann Chart, or (b) of such opacity as to obscure an observer's view to a degree equal to or greater than does smoke described in (a).

Substantive requirements of this rule are potentially applicable since cap construction activities have a potential to produce visible emissions due to fugitive dust. Mitigation measures such as wetting the soil will be implemented to reduce visible emissions.

4.2.2.2 California Fish and Game Requirements

California Department of Fish and Game identified the following requirements as potential ARARs pertaining to actions affecting biological resources for the remedial action at Site 8, Units 1 and 4.

- Cal. Fish and Game Code §§ 1908, 2080, 5650, 3005, 2008, 3003.1, 3551, 4700, 5050, 3503, 3503.5, 3800, 4000 – 4012, 4750, 4800 – 4809, and 5515
- Cal. Fish and Game Commission Wetlands Policy
- Cal. Code Regs. tit. 14 §§ 40, 460, 465, 472, and 475

The ARAR analysis of the above-mentioned regulations indicated that following ARARs are potentially relevant and appropriate to remedial action at Site 8, Units 1 and 4 (see Table C-4):

- Cal. Fish and Game Code §§ 3005; 3503; 3503.5; 3800; and 4150

- Cal. Code Regs. tit. 14 § 472

Cal. Fish and Game Code § 3005

This regulation prohibits the taking of birds and mammals, including the taking by poison. The procedural aspects of this regulation are not ARARs. Certain substantive provisions pertaining to take of birds or mammals with a poisonous substance are potentially applicable. Precautions will be taken during cap construction at Site 8, Units 1 and 4 to prevent bird and mammal exposure to contaminated soil.

Cal. Fish and Game Code § 3503

The regulation prohibits the take, possession, or needless destruction of the nest or eggs of any bird, except as otherwise provided by this code or any regulation made pursuant thereto. Precautions will be taken during cap construction at Site 8 to prevent bird exposure to contaminated soil.

Cal. Fish and Game Code § 3503.5

This regulation prohibits take, possession, or destruction of any birds in the orders Falconiformes or Strigiformes (birds-of-prey) or to take, possess, or destroy the nest or eggs of any such bird except as otherwise provided by this code or any regulation adopted pursuant thereto. The substantive requirements of this regulation are potentially applicable if the birds in the orders of Falconiforms or Strigiformes (birds of prey) or their eggs are identified at Site 8, Units 1 and 4. Precautions will be taken to prevent exposure of these birds to contaminated soil during cap construction at Site 8.

Cal. Fish and Game Code § 3800

This regulation prohibits the take of nongame birds, except in accordance with regulations of the commission, or when related to mining operations with a mitigation plan approved by the department. This section further provides requirements concerning mitigation plans related to mining. The substantive requirements of this regulation are potentially applicable if the nongame birds or their eggs are located at Site 8. Precautions will be taken to prevent exposure of these birds to contaminated soil during cap construction at Site 8.

Cal. Fish and Game Code § 3800

This regulation prohibits taking and possession of nongame mammals, or their part, except as provided in this code or in accordance with regulations adopted by the commission. Nongame mammals are those occurring naturally in California, which are not game mammals, fully protected mammals, or fur-bearing mammals. The substantive requirements of this regulation are potentially applicable if the nongame mammals are located at Site 8, Units 1 and 4. Precautions will be taken to prevent exposure of these mammals to contaminated soil during cap construction at Site 8.

Cal. Code Regs. tit. 14 § 472

This regulation provides that nongame birds and mammals may not be taken except as provided in subsections (a) through (d) of Cal. Code Regs. tit. 14 § 472 and Sections 478 and 485. The substantive requirements of this regulation are potentially applicable if the nongame animals are located at Site 8, Units 1 and 4. Precautions will be taken to prevent exposure of these mammals to contaminated soil during cap construction at Site 8.

4.2.2.3 National Pollutant Discharge Elimination System (NPDES) General Permit for Storm Water Discharges Associated with Construction Activity (General Permit)

Since the remedial action may result in disturbance of at least one acre at Site 8, Units 1 and 4, the state of California identified Water Quality Order No. 99-08-DWQ and the NPDES General Permit for Storm Water Discharges Associated with Construction Activity (General Permit) as potential ARARs. The DON has determined that Section 121(e)(1) of CERCLA and the corresponding provision in the NCP (40 C.F.R Section 300.400[e][1]) apply to the discharge of storm water from the remedial action area at Site 8 and that an NPDES permit (either general or individual) is not required for that discharge. However, DON will comply with the substantive provisions of the NPDES General Permit identified by the state of California, as "TBC" guidance for compliance with the federal Clean Water Act and state of California water quality requirements including substantive requirements for development and implementation of BMPs and substantive requirements for the content of a storm water pollution prevention plan (SWPPP). Compliance with these substantive requirements will be documented as Storm Water Management Plan in the Remedial Action Work Plan. This plan will include a description of BMPs to be implemented during the remedial action and address substantive SWPPP content requirements.

4.2.3 Conclusions

Since Ra-226 is the COPC at Site 8, Units 1 and 4, the federal ARARs for Alternative 2 include, U.S. NRC requirements at 10 C.F.R § 20.1403 (a) and (b). Cap construction may lead to pollutant emissions into the atmosphere; therefore, the SCAQMD rules 401, 403, 404, and 405 are potentially applicable to capping at Site 8. Additionally, California Fish and Game regulations at Cal. Fish and Game Code §§ 3005; 3503; 3503.5; 3800; and 4150, and Cal. Code Regs. tit. 14 § 472, are potential ARARs for protection of biological resources during capping.

4.3 Alternative 3 – Excavation and Off-site Disposal

Alternative 3 includes excavation of contaminated soil exceeding Ra-226 cleanup goal (established based on the RAOs) for residential (unrestricted) reuse. The excavated soil will be disposed at a commercial facility licensed to receive Ra-226 contaminated soil.

4.3.1 Federal ARARs

4.3.1.1 U.S. Nuclear Regulatory Commission Standards for Protection Against Radiation

Alternative 3 includes remediation of Ra-226 contaminated soil; therefore, the NRC standards for protection against radiation at 10 C.F.R § 20 were evaluated to determine whether they were potential federal ARARs. This evaluation indicated that NRC requirements at 10 C.F.R § 20.1402 are potential ARARs for Alternative 3.

4.3.1.2 SCAQMD Requirements

The federal ARARs for air emissions for Alternative 3 are same as those for Alternative 2 (see Section 4.1.2)

4.3.2 State ARARs

4.3.2.1 SCAQMD Requirements

SCAQMD Rules 401, 402, 408, 431.1, 431.2, and 431.3; Regulation X; Regulation XI, Rule 1150; and Regulation XIV, Rule 1401 were identified as potential state ARARs for the air emissions at Site 8, Units 1 and 4. The ARAR evaluation of these rules indicated that substantive requirements of Rule 401 are potentially applicable to Alternative 3.

4.3.2.2 CALIFORNIA FISH AND GAME REQUIREMENTS

California Department of Fish and Game ARARs for Alternative 3 are same as those for Alternative 2 (see Section 4.2.2).

4.3.3 Conclusions

Since Ra-226 is the COPC at Site 8, Units 1 and 4, the federal ARARs for Alternative 3 include, U.S. NRC requirements at 10 C.F.R § 20.1402. Excavation and earth-moving operations may lead to pollutant emissions into the atmosphere; therefore, the SCAQMD rules 401, 403, 404, and 405 are potentially applicable to Alternative 3. Additionally, California Fish and Game regulations at Cal. Fish and Game Code §§ 3005; 3503; 3503.5; 3800; and 4150, and Cal. Code Regs. tit. 14 § 472, are potential ARARs for protection of biological resources during implementation of Alternative 3.

Table C-1: Potential Federal Chemical-Specific[a] ARARs for Remedial Action at Site 8, Units 1 and 4

Requirement	Prerequisite	Citation [b]	ARAR Determination	Comments
SOIL				
Resource Conservation and Recovery Act (42 U.S.C., ch. 82, §§ 6901–6991[i]) [c]				
Defines RCRA hazardous waste. A solid waste is characterized as toxic, based on the toxicity characteristic leaching procedure (TCLP), if the waste exceeds the TCLP maximum concentrations.	Waste	Cal. Code Regs. tit. 22 § 66261.21, 66261.22(a)(1), 66261.23, 66261.24(a)(1), and 66261.100	Applicable	Applicable for determining whether waste is hazardous.
Groundwater Protection Standards: Requirements to ensure that hazardous constituents entering the groundwater from a regulated unit do not exceed the concentration limits for contaminants of concern in the uppermost aquifer underlying the waste management area of concern at the point of compliance.	A regulated unit that receives or has received hazardous waste before 26 July 1982 or regulated units that ceased receiving hazardous waste prior to 26 July 1982 where constituents in or derived from the waste may pose a threat to human health or the environment.	Cal. Code Regs. tit. 22 § 66264.94 (a)(1) and (3), (c), (d), and (e)	Relevant and Appropriate	While Site 8 does not pose a current threat to groundwater, substantive requirements of the cited regulations are relevant and appropriate for soil/vadose zone contamination. Since Ra-226 is relatively immobile and is likely restricted to the shallow soil, and Ra-226 vadose zone standards will be met with remedial alternatives considered, this ARAR is met.
Uranium Mill Tailings Radiation Control Act (42 U.S.C., ch. 88, §§ 192.02, 192.12(a,b), 192.42) [c]				
Control of residual radioactive materials shall be designed to: Be effective for up to one thousand years, to the extent reasonably achievable, and, in any case, for at least 200 years, and, Provide reasonable assurance that releases of radon-222 from residual radioactive material to the atmosphere will not: (1) Exceed an average release rate of 20 picocuries per square meter per second. This average shall apply over the entire surface of the disposal site and over at least a one-year period. Radon will come from both residual radioactive materials and from materials covering them. Radon emissions from the covering materials should be estimated as part of developing a remedial action plan for each site. The standard, however, applies only to emissions from residual radioactive materials to the atmosphere. Or, (2) Increase the annual average concentration of radon-222 in air at or above any location outside the disposal site by more than 0.5 picocurie per liter.	Inactive Uranium Processing sites	40 C.F.R §192.02(a),(b)	Not an ARAR	It is highly unlikely the criteria for releases of radon-222 from residual radiological material to the atmosphere would be exceeded at Units 1 and 4 of Site 8
Standards for Cleanup of Land and Buildings Contaminated with Radium-226, Radium-228, and Thorium from Inactive Uranium Processing Sites. As a result of residual radiological materials	UMTRCA sites	40 C.F.R §192.12(a) §192.32(b)(2) and §192.41	Relevant and Appropriate	Since Site 8 is not a UMTRCA site, the requirements of UMTRCA are not applicable to remedial action for Ra-226 at Site 8. However, since the radiological contaminant at Site 8 (Ra-226) is similar to that existing at a UMTRCA site, the cited requirements

Table C-1: Potential Federal Chemical-Specific[a] ARARs for Remedial Action at Site 8, Units 1 and 4

Requirement	Prerequisite	Citation [b]	ARAR Determination	Comments
from any designated processing site: (a) The concentration of radium-226 in land averaged over any area of 100 square meters shall not exceed the background level by more than: (1) 5 pCi/g, averaged over the first 15 cm of soil below the surface, and (2) (2) 15 pCi/g, averaged over 15 cm thick layers of soil more than 15 cm below the surface.				are potentially relevant and appropriate for an unrestricted land-use.
In any occupied or habitable building the objective of remedial action shall be, and reasonable effort shall be made to achieve, an annual average (or equivalent) radon decay product concentration (including background) not to exceed 0.02 working level (WL). In any case, the radon decay product concentration (including background) shall not exceed 0.03 WL. Provisions applicable to radon-222 shall also apply to radon-220.	UMTRCA sites	40 C.F.R § 192.12(b)(1)§ 192.41(b)	Relevant and Appropriate	These provisions are potentially relevant and appropriate if habitable building is constructed at Units 1 and 4 of Site 8 as a part of site reuse.
Concentration limits for cleanup of gamma radiation in buildings at inactive uranium processing sites designated for remedial action. In any occupied or habitable building, the level of gamma radiation shall not exceed the background level by more than 20 microroentgens per hour.	UMTRCA sites	40 C.F.R. § 192.12(b)(2)	Relevant and Appropriate	These provisions are potentially relevant and appropriate if habitable building is constructed at Units 1 and 4 of Site 8 as a part of site reuse.
Radiological Criteria for License Termination				
A site will be considered acceptable for unrestricted use if the residual radioactivity that is distinguishable from background radiation results in TEDE to an average member of the critical group that does not exceed 25 mrem/yr, including that from groundwater sources of drinking water, and that the residual radioactivity has been reduced to as low as reasonably achievable (ALARA).	Existing NRC-licensed radiologically-contaminated site.	10 C.F.R. § 20.1402	Relevant and Appropriate	Site 8 is not a NRC-licensed radiologically-contaminated site. In addition, Ra-226 is not a NRC-regulated material. This ARAR is potentially relevant and appropriate for an unrestricted land use scenario.
As a condition for license termination with restricted site use, the licensee must demonstrate that further reductions in residual radioactivity necessary to comply with the provisions of 10 U.S.C. § 20.1402 would result in net public or environmental harm or were not being made because the residual levels associated with restricted conditions are ALARA.	Existing NRC-licensed radiologically-contaminated site.	10 C.F.R. § 20.1403(a)	Relevant and Appropriate	Site 8 is not a NRC-licensed radiologically-contaminated site. In addition, Ra-226 is not a NRC-regulated material. Potentially relevant and appropriate for restricted land use scenario.

Table C-1: Potential Federal Chemical-Specific[a] ARARs for Remedial Action at Site 8, Units 1 and 4

Requirement	Prerequisite	Citation [b]	ARAR Determination	Comments
As a condition for license termination with restricted site use, the licensee must make provisions for legally enforceable institutional controls that provide reasonable assurance that the TEDE from residual radioactivity distinguishable from background to the average member of the critical group will not exceed 25 mrem/yr.	Existing NRC-licensed radiologically-contaminated site.	10 C.F.R. § 20.1403(b)	Relevant and Appropriate	Site 8 is not a NRC-licensed radiologically-contaminated site. In addition, Ra-226 is not a NRC-regulated material. Potentially relevant and appropriate for restricted land use scenario.
Alternate criteria are allowed for license termination as long as assurance is provided that public health and safety would continue to be protected, and that it is unlikely that the dose from all man-made sources combined, other than medical, would be more than the 100 mrem/yr limit of subpart D, by submitting an analysis of possible sources of exposure; to the extent practical restrictions on site use are employed according to the provisions of § 20.1403 in minimizing exposures at the site; and doses are reduced to ALARA levels, taking into consideration any detriments such as traffic accidents expected to potentially result from decontamination and waste disposal.	Existing NRC-licensed radiologically-contaminated site.	10 C.F.R. §§20.1404(a)(1) - (a) (3)	Relevant and Appropriate	Site 8 is not a NRC-licensed radiologically-contaminated site. In addition, Ra-226 is not a NRC-regulated material. Potentially relevant and appropriate for restricted land use scenario.
Provides a benchmark approach for setting cleanup levels for radionuclides as a supplement to 40 C.F.R. §192	UMTRCA site	10 C.F.R. Part 40 Appendix A, pt. I, Criterion 6(6)	Relevant and Appropriate.	Provides design standards for radon gas control at sites where residual radionuclides exceed the background level by more than: (i) 5 pCi/g for Ra-226, or in the case of thorium byproduct material, Ra-228, averaged over the first 15 cm below the surface, and 15 pCi/g of Ra-226, or in the case of thorium byproduct material, Ra-228, averaged over 15 cm thick layers more than 15 cm below the surface. However it is anticipated that following remediation, the Ra-226 will be will be below the concentrations stated above.
Performance objectives for the land disposal of LLW. Concentrations of radioactive material that may be released to the general environment must not result in an annual dose exceeding 25 mrem to the body or any organ of a member of the general public.	Existing NRC-licensed LLW disposal site	10 C.F.R § 61.41	Relevant and Appropriate	Since Ra-226 contaminated soil is similar to LLW, the requirements of 10 C.F.R § 61.41 are considered potentially relevant and appropriate if the Ra-226 contaminated soil is left in-place as a part of remedial action.
AIR				
Clean Air Act (42 U.S.C., ch. 85, §§ 7401–7671) [c]				
NAAQS: Primary and secondary standards for ambient air quality to protect public health and	Contamination of air affecting public	40 C.F.R. § 0.4–50.12	Not an ARAR	Not enforceable and therefore not an ARAR.

Table C-1: Potential Federal Chemical-Specific[a] ARARs for Remedial Action at Site 8, Units 1 and 4

Requirement	Prerequisite	Citation [b]	ARAR Determination	Comments
welfare (including standards for particulate matter and lead).	health and welfare.			
Resource Conservation and Recovery Act Air Emissions Requirements (42 U.S.C., ch. 82, §§ 6901–6991[i])[c]				
Air emission standards for process vents or equipment leaks.	Equipment that contains or contacts hazardous waste with organic concentrations of at least 10 percent by weight or process vents associated with specified operations that manage hazardous wastes with organic concentrations of at least 10 ppmw.	Cal. Code Regs. tit. 22, § 66264.1030–66264.1034, excluding .1030(c), .1033(j), .1034(c)(2), .1034(d)(2) Cal. Code Regs. tit. 22, § 66264.1050– 66264.1063, excluding .1050(c), (d), .1057(g)(2), .1060, .1063(d)(3)	Not an ARAR	Negligible concentrations of VOCs have been detected at Site 8, Units 1 and 4.

Notes:

[a] many potential action-specific ARARs contain chemical-specific limitations and are addressed in the action-specific ARAR tables

[b] only the substantive provisions of the requirements cited in this table are potential ARARs

[c] statutes and policies, and their citations, are provided as headings to identify general categories of potential ARARs for the convenience of the reader; listing the statutes and policies does not indicate that the DON accepts the entire statutes or policies as potential ARARs; specific potential ARARs are addressed in the table below each general heading; only pertinent substantive requirements of the specific citations are considered potential ARARs.

Acronyms/Abbreviations:

§	section	pCi/g	pico-Curie per gram
ALARA	as low as is reasonably achievable	RCRA	Resource Conservation and Recovery Act
ARAR	applicable or relevant and appropriate requirement	TCLP	toxicity characteristic leaching procedure
Cal. Code Regs.	*California Code of Regulations*	tit.	title
ch.	chapter	UMTRCA	Uranium Mill Tailings Radiation Control Act
cm	centimeter	U.S.C.	*United States Code*
DON	Department of the Navy		
mrem	millirem		
NRC	Nuclear Regulatory Commission		

Table C-2: Potential State Chemical-Specific[a] ARARs for Remedial Action at Sites 8, Units 1 and 4

Requirement	Prerequisite	Citation[b]	ARAR Determination	Comments
Cal/EPA Department of Toxic Substances Control[c]				
Defines "non-RCRA hazardous waste"	Waste	Cal. Code Regs. tit. 22 § 66261.22(a)(3) and (4), § 66261.24(a)(2)–(a)(8), § 66261.101, § 66261.3(a)(2)(C), and § 66261.3(a)(2)(F)	Applicable	Applicable for determining whether a waste is a non-RCRA hazardous waste.
Establishes concentration limits for cleanup actions, including groundwater, surface water, and the unsaturated zones for other than hazardous waste at background. Allows a higher cleanup limit (but not to exceed MCLs) if background is not technically or economically achievable.		Cal. Code Regs. tit. 27, §§ 20380(a); 20400(a), (c), (d), (e), and (g); and 20405	Not an ARAR	Not more stringent than federal regulations at Cal. Code Regs. tit. 22, § 66264.94 (see Section 2.1.3.2 for additional discussion).
Establishes concentration limits for cleanup actions, including groundwater, surface water, and the unsaturated zones for other than hazardous waste at background. Allows a higher cleanup limit (but not to exceed maximum contaminant levels) if background is not technically or economically achievable.		Cal. Code Regs. tit. 27 § 20400	Not an ARAR	Not more stringent than federal regulations at Cal. Code Regs. tit. 22 § 66264.94. Additionally, the Ra-226 contamination at Site 8 is limited to shallow soil, and does not pose a threat to groundwater beneath the site.
Definitions of designated waste, nonhazardous waste, and inert waste.		Cal. Code Regs. tit. 27, §§ 20210, 20220, and 20230	Applicable	Potential ARARs for classifying waste and determining ARAR status of other requirements (see Section 1.4.3 for additional discussion).
California Department of Health Services[c]				
Standards for Protection from Radiation. This regulation incorporates 10 CFR Part 20, §§ 20.1001 through 20.2402 and Appendices A through G by reference.		Cal. Code Regs. tit 17, § 30253	Not an ARAR	These standards incorporate by reference the federal standards at 10 CFR Part 20. Since they are not more stringent than federal requirements, they are not potential ARARs

Notes:

[a] many potential action-specific ARARs contain chemical-specific limitations and are addressed in the action-specific ARAR tables

[b] only the substantive provisions of the requirements cited in this table are potential ARARs

[c] statutes and policies, and their citations, are provided as headings to identify general categories of potential ARARs for the convenience of the reader; listing the statutes and policies does not indicate that the DON accepts the entire statutes or policies as potential ARARs; specific potential ARARs are addressed in the table below each general heading; only pertinent substantive requirements of specific citations are considered potential ARARs.

Acronyms/Abbreviations:

§	section
ARAR	applicable or relevant and appropriate requirement
Cal. Code Regs.	*California Code of Regulations*
Cal/EPA	California Environmental Protection Agency
RCRA	Resource Conservation and Recovery Act
tit.	title

Table C-3: Federal Action-Specific ARARs for Remedial Action at Site 8, Units 1 and 4

Remedial Action Alternatives: *Alternative 1* – No Action, *Alternative 2* – Asphalt Cap Plus Institutional Controls and Access Restrictions, *Alternative 3* – Excavation and Off-site Disposal

Action/ Requirement	Requirement	Prerequisite	Citation	ARAR Determination			Comments
				A	RA	TBC	
Resource Conservation and Recovery Act (42 U.S.C. §§ 6901–6991[I])*							
Onsite waste generation	Person who generates waste shall determine if that waste is a hazardous waste.	Generator of waste	Cal. Code Regs. tit. 22 § 66262.10(a), 66262.11	3			Potentially applicable for any operation where waste is generated. Determination of whether wastes generated during remedial action are hazardous will be made as wastes are excavated.
	Requirements for analyzing waste for determining whether waste is hazardous.	Generator of waste.	Cal. Code Regs. tit. 22, § 66264.13(a) and (b)	3			Potentially applicable for analysis of waste during the remedial action.
Hazardous waste accumulation	Onsite hazardous waste accumulation is allowed for up to 90 days as long as the waste is stored in containers in accordance with § 66262.171–178 or in tanks, on drip pads, inside buildings, and is labeled and dated, etc.	Accumulate hazardous waste	Cal. Code Regs. tit. 22 § 66262.34	3			Substantive requirements are potentially applicable for accumulation of waste for less than 90 days if the waste is hazardous waste and is stored on site. Wastes will not be stored on site for greater than 90 days.
Site closure	Minimize the need for further maintenance controls and minimize or eliminate, to the extent necessary to protect human health and the environment, post-closure escape of hazardous waste, hazardous constituents, leachate, contaminated rainfall or runoff, or waste decomposition products to groundwater or surface water or to the atmosphere.	Hazardous waste management facility	Cal. Code Regs. tit. 22 § 66264.111(a) and (b)		3		Substantive requirements are potentially relevant and appropriate for clean closure determination for Units 1 and 4 of Site 8.
Container storage	Containers of RCRA hazardous waste must be - maintained in good condition, - compatible with hazardous waste to be stored, and - closed during storage except to add or remove waste.	Storage of RCRA hazardous waste not meeting small-quantity generator criteria before treatment, disposal, or storage elsewhere, in a container.	Cal. Code Regs. tit. 22 § 66264.171, .172, .173		3		Substantive requirements are potentially relevant and appropriate for accumulation of waste for less than 90 days if the waste is hazardous waste and is stored on site. Wastes will not be stored on site for greater than 90 days.
	Inspect container storage areas weekly for deterioration.		Cal. Code Regs. tit. 22 § 66264.174		3		Substantive requirements for inspection of container storage areas are potentially relevant and appropriate if the wastes are determined to be hazardous and are stored on site for less than 90 days.
	Place containers on a sloped, crack-free base, and protect from contact with accumulated liquid. Provide containment system with a capacity of 10 percent of the volume of containers of free liquids. Remove spilled or leaked waste in a timely manner to prevent overflow of the containment system.		Cal. Code Regs. tit. 22 § 66264.175(a) and (b)		3		Substantive requirements are potentially relevant and appropriate for accumulation of waste for less than 90 days if the waste is hazardous waste and is stored on site. Wastes will not be stored on site for greater than 90 days.

Table C-3: Federal Action-Specific ARARs for Remedial Action at Site 8, Units 1 and 4

Remedial Action Alternatives: *Alternative 1* – No Action, *Alternative 2* – Asphalt Cap Plus Institutional Controls and Access Restrictions, *Alternative 3* – Excavation and Off-site Disposal

Action/ Requirement	Requirement	Prerequisite	Citation	ARAR Determination			Comments
				A	RA	TBC	
	At closure, remove all hazardous waste and residues from the containment system, and decontaminate or remove all containers and liners.		Cal. Code Regs. tit. 22 § 66264.178		3		Substantive requirements are potentially relevant and appropriate for accumulation of waste for less than 90 days if the waste is hazardous waste and is stored on site. Wastes will not be stored on site for greater than 90 days.
Waste pile	Allows generator to accumulate solid remediation waste in a EPA-designated pile for storage only, up to 2 years, during remedial operations without triggering land disposal restrictions.	Hazardous remediation waste temporarily stored in piles.	40 C.F.R. § 264.554(d)(1)(i–ii) and (d)(2), (e), (f), (h), (i), (j), and (k)		3		The substantive requirements are potentially relevant and appropriate for storage of excavated soil at Site 8. The staging pile will be designed to prevent or minimize the releases of COPCs into the environment, and minimize or adequately control cross-media transfer of pollutants.
Monitoring	Owners/operators of RCRA surface impoundment, waste pile, land treatment unit, or landfill shall conduct a monitoring and response program for each regulated unit.	Surface impoundment, waste pile, land treatment unit, or landfill for which constituents in or derived from waste in the unit may pose a threat to human health or the environment.	Cal. Code Regs. tit. 22, § 66264.91(a)(1)–(4)and (c), except as it cross-references permit requirements				Not an ARAR. The soil contamination at Site 8, Units 1 and 4 is surficial and has been adequately delineated during previous investigations. These studies indicate that the soil contamination at these sites is limited to the shallow soil, and does not pose a threat to groundwater beneath the sites. Therefore, detection, evaluation or corrective action monitoring are not required and hence do not constitute ARARs for response actions at IRP Site 8.
Monitoring	Requires specification of COCs for monitoring, reasonably expected to be in or derived from the waste contained in the waste management unit.		Cal. Code Regs. tit. 22 § 66264.93				Not an ARAR. Previous radiological investigations at Site 8 have adequately delineated the nature and extent of radiological contamination at Units 1 and 4 (Weston 2000 and Weston 2004b). These studies concluded that the soil contamination at Units 1 and 4 is limited to the shallow soil, and does not pose a threat to groundwater beneath the site. Therefore, no further specification of COCs is required for monitoring as a part of response actions at IRP Sites 8 and 12.
Monitoring	Requires monitoring for compliance with remedial action objectives for 3 years from the date of achieving cleanup levels.		Cal. Code Regs. tit. 22 § 66264.96				Not an ARAR. The contamination at Site 8 is limited to shallow soil, and does not pose a threat to groundwater beneath the site. Therefore, groundwater monitoring for compliance is not required

Table C-3: Federal Action-Specific ARARs for Remedial Action at Site 8, Units 1 and 4

Remedial Action Alternatives: *Alternative 1* – No Action, *Alternative 2* – Asphalt Cap Plus Institutional Controls and Access Restrictions, *Alternative 3* – Excavation and Off-site Disposal

Action/ Requirement	Requirement	Prerequisite	Citation	ARAR Determination			Comments
				A	RA	TBC	
Monitoring	Requirements for monitoring groundwater, surface water, and the vadose zone.	Hazardous waste treatment, storage, or disposal facility.	Cal. Code Regs. tit. 22 § 66264.97				Not an ARAR. Previous radiological investigations at Site 8 have adequately delineated the nature and extent of radiological contamination at Units 1 and 4 (Weston 2000 and Weston 2004b). These studies concluded that the soil contamination at Units 1 and 4 is limited to the shallow soil, and does not pose a threat to groundwater beneath the site. Therefore, no further monitoring for assessment of release is required as a part of remedial action at Site 8, Units 1 and 4.
	Requirements for a detection monitoring program.	Hazardous waste treatment, storage, or disposal facility.	Cal. Code Regs. tit. 22, § 66264.98(e)(1-5), (i), (j), (k)(1-3), (4)(A) and (D),(5), (7)(C) and (D),(n)(1),(2)(B), and (C)				Not an ARAR. Previous radiological investigations at Site 8 have adequately delineated the nature and extent of radiological contamination at Units 1 and 4 (Weston 2000 and Weston 2004b). These studies concluded that the soil contamination at Units 1 and 4 is limited to the shallow soil, and does not pose a threat to groundwater beneath the site. Therefore, no further monitoring for assessment of release is required as a part of remedial action at Site 8, Units 1 and 4.
	Requirements for an evaluation monitoring program.	Hazardous waste treatment, storage, or disposal facility.	Cal. Code Regs. tit. 22, § 66264.99(b), (e)(1)–(6), (f)(3), and (g)				Not an ARAR. Previous radiological investigations at Site 8 have adequately delineated the nature and extent of radiological contamination at Units 1 and 4 (Weston 2000 and Weston 2004b). These studies concluded that the soil contamination at Units 1 and 4 is limited to the shallow soil, and does not pose a threat to groundwater beneath the site. Therefore, no further monitoring for assessment of release is required as a part of remedial action at Site 8, Units 1 and 4.

Table C-3: Federal Action-Specific ARARs for Remedial Action at Site 8, Units 1 and 4

Remedial Action Alternatives: *Alternative 1* – No Action, *Alternative 2* – Asphalt Cap Plus Institutional Controls and Access Restrictions, *Alternative 3* – Excavation and Off-site Disposal

Action/ Requirement	Requirement	Prerequisite	Citation	ARAR Determination			Comments
				A	RA	TBC	
Corrective action	The owner or operator required to take corrective action under Cal. Code Regs. tit. 22, § 66264.91 shall take corrective action to remediate releases from the regulated unit and to ensure that the regulated unit achieves compliance with the water quality protection standard.	Hazardous waste treatment, storage, or disposal facility.	Cal. Code Regs. tit. 22, § 66264.100(b)				Not an ARAR. Previous radiological investigations at Site 8 have adequately delineated the nature and extent of radiological contamination at Units 1 and 4 (Weston 2000 and Weston 2004b). These studies concluded that the soil contamination at Units 1 and 4 is limited to the shallow soil, and does not pose a threat to groundwater beneath the site. Therefore, no further monitoring for assessment of release is required as a part of remedial action at Site 8, Units 1 and 4.
	The owner or operator shall implement corrective action measures that ensure that constituents of concern achieve their respective concentration limits at all monitoring points and throughout the zone affected by the release, including any portions of the affected zone that extend beyond the facility boundary, by removing the waste constituents or treating them in place. The owner or operator shall take other action to prevent noncompliance due to a continued or subsequent release including, but not limited to, source control.	Hazardous waste treatment, storage, or disposal facility.	Cal. Code Regs. tit. 22, § 66264.100(c)				Not an ARAR. Previous radiological investigations at Site 8 have adequately delineated the nature and extent of radiological contamination at Units 1 and 4 (Weston 2000 and Weston 2004b). These studies concluded that the soil contamination at Units 1 and 4 is limited to the shallow soil, and does not pose a threat to groundwater beneath the site. Therefore, no further monitoring for assessment of release is required as a part of remedial action at Site 8, Units 1 and 4.
South Coast Air Quality Management District (SCAQMD)*							
Air Emission	Prohibits emissions of fugitive dust such that the presence of such dust remains visible in the atmosphere beyond the property line of the emission source and shall not cause or allow PM_{10} levels to exceed 50 micrograms per cubic meter when determined, by simultaneous sampling, as the difference between upwind and downwind samples		SCAQMD Rule 403	2, 3			Fugitive dust emissions of particulate matter are expected from the excavation and waste handling. Measures such as applying water to minimize fugitive dust emissions may be required.
	Limits equipment from discharging particulate emissions in excess of 0.01 to 0.196 grain per cubic foot based on a given volumetric (dry standard cubic feet per minute) exhaust gas flow rate averaged over one hour or on cycle of operation. It excludes steam generators or gas turbines.		SCAQMD Rule 404	2, 3			The equipment used will comply with substantive requirements of this rule.
	Limits equipment from discharging particulate emissions in excess of 0.99 to 30 pounds per hour based on a given process weight.		SCAQMD Rule 405	2, 3			The equipment used will comply with substantive requirements of this rule.
	Limits equipment from discharging carbon monoxide emissions in excess of 2000 ppm and sulfur dioxide		SCAQMD Rule 407				Not an ARAR. Not pertinent to remedial action.

Table C-3: Federal Action-Specific ARARs for Remedial Action at Site 8, Units 1 and 4

Remedial Action Alternatives: *Alternative 1* – No Action, *Alternative 2* – Asphalt Cap Plus Institutional Controls and Access Restrictions, *Alternative 3* – Excavation and Off-site Disposal

Action/ Requirement	Requirement	Prerequisite	Citation	ARAR Determination			Comments
				A	RA	TBC	
	emissions of 500 ppm or greater averaged over 15 minutes. It excludes stationary internal combustion engines, propulsion of mobile equipment or emergency venting.						
	Limits the emissions of particulate matter from the exhaust of a combustion source (such as a gas turbine) to 0.23 grams per cubic meter (0.1 grains per standard cubic foot) at 12 percent carbon dioxide averaged over 15 minutes. It excludes internal combustion engines.		SCAQMD Rule 409				Not an ARAR. Not pertinent to remedial action.
	Limits concentration of oxides of nitrogen (as nitrogen dioxide) averaged over 15 minutes, from any non-mobile fuel burning equipment, to a range of 125 to 300 ppm for gaseous fuels and 225 to 400 ppm for solid and liquid fuels depending on equipment size.		SCAQMD Rule 474				Not an ARAR. Not pertinent to remedial action.
	Limits emissions of volatile organic compounds (VOCs) from contaminated soil to less than 50 ppm. For contaminated soil with 50 ppm or greater, an approved mitigation plan, describing removal methods and mitigation measures, must be obtained from the District prior to proceeding with the excavation. Uncontrolled spreading of contaminated soil is not permitted.		SCAQMD Rule 1166				Not an ARAR. Very low concentrations of VOCs were detected at Site 8. Therefore, negligible VOC emissions are expected during the remedial action.
	Applies to any new or modified equipment, which may cause the issuance of any non-attainment air contaminant, ozone depleting compound or ammonia. It requires all equipment to be constructed with best available control technology (BACT). For non-attainment emission increases, it requires the emission increases to be offset and substantiated with modeling that the equipment will not cause a significant increase in concentrations of non-attainment contaminants.		SCAQMD Regulation XIII				Not an ARAR. No equipment with potential to issue non-attainment air contaminant, ozone depleting compound or ammonia is planned for the remedial action.

Note:

* statutes and policies, and their citations, are provided as headings to identify general categories of potential ARARs for the convenience of the reader. Listing the statutes and policies does not indicate that the DON accepts the entire statutes or policies as potential ARARs; specific potential ARARs are addressed in the table below each general heading; only substantive requirements of specific citations are considered potential ARARs.

Acronyms/Abbreviations:

§	section
ALARA	As low as is reasonably achievable
ARAR	Applicable or relevant and appropriate requirement
BACT	best available control technology
BMPs	best management practices
Cal. Code	California Code of Regulations

Regs.	
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
C.F.R	Code of Federal Regulations
DON	Department of the Navy
EPA	Environmental Protection Agency
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual
mrem	millirem
mSv	millisievert
NRC	Nuclear Regulatory Commission
Ra-226	radium-226
RCRA	Resource Conservation and Recovery Act
SCAQMD	South Coast Air Quality Management District
TBC	to be considered
tit.	Title
U.S.C	United States Code

Table C-4: State Action-Specific ARARs for Remedial Action at Site 8, Units 1 and 4

Remedial Action Alternatives: *Alternative 1* – No Action, *Alternative 2* – Asphalt Cap Plus Institutional Controls and Access Restrictions, *Alternative 3* – Excavation and Off-site Disposal

Action	Requirement	Prerequisite	Citation	ARAR Determination			Comments
				A	RA	TBC	
State Water Resources Control Board (SWRCB) and Regional Water Quality Control Board (RWQCB)*							
Storm water discharges	Construction and earth-moving activities that result in disturbance of at least one acre are subject to Water Quality Order No. 99-08-DWQ and the National Pollutant Discharge Elimination System (NPDES) General Permit for Storm Water Discharges Associated with Construction Activity (General Permit). Such activities include, but are not limited to, clearing, grading, stockpiling and excavation of soil or other materials.	Construction activity that results in disturbance of at least one acre	NPDES General Permit for Storm Water Discharges Associated with Construction Activity (General Permit)			2, 3	Since the remedial action will result in disturbance of at least one acre at Site 8, Units 1 and 4, the state of California identified Water Quality Order No. 99-08-DWQ and the NPDES General Permit for Storm Water Discharges Associated with Construction Activity (General Permit) as potential ARARs. The DON has determined that Section 121 (e)(1) of CERCLA and the corresponding provision in the NCP (40 C.F.R Section 300.400[e][1]) apply to the discharge of storm water from the remedial action area at Site 8 and that an NPDES permit (either general or individual) is not required for that discharge. However, DON will comply with the substantive provisions of the NPDES General Permit identified by the state of California, as "TBC" guidance for compliance with the federal Clean Water Act and state of California water quality requirements including substantive requirements for development and implementation of BMPs and substantive requirements for the content of a storm water pollution prevention plan (SWPPP). Compliance with these substantive requirements will be documented as Storm Water Management Plan in the Remedial Action Work Plan. This plan will include a description of BMPs to be implemented during the remedial action and address substantive SWPPP content requirements.
Disposal of Waste	Requires that designated waste as defined at Cal. Water Code § 13173 be discharged to Class I or Class II waste management units.	Discharges of designated waste after 18 July 1997 (nonhazardous waste that could cause degradation of surface or groundwaters) to land for treatment, storage, or disposal.	Cal. Code Regs. tit. 27 § 20210	3			Potentially applicable if the excavated soil is characterized as designated waste.
	Requires that nonhazardous solid waste as defined at § 20220(a) be discharged to a classified waste management unit.	Discharge of nonhazardous solid waste after 18 July 1997 to land for treatment, storage, or disposal.	Cal. Code Regs. tit. 27, § 20220(b), (c), and (d)	3			Potentially applicable if the excavated soil is characterized as nonhazardous waste.
	Inert waste as defined at Cal. Code Regs. tit. 27 § 20230(a) need not be discharged at a classified unit	Applies to discharges of inert waste to land after 18 July 1997 for treatment, storage, or disposal.	Cal. Code Regs. tit. 27, § 20230(b)	3			Potentially applicable if the excavated soil is characterized as inert waste.

Table C-4: State Action-Specific ARARs for Remedial Action at Site 8, Units 1 and 4

Remedial Action Alternatives: *Alternative 1* – No Action, *Alternative 2* – Asphalt Cap Plus Institutional Controls and Access Restrictions, *Alternative 3* – Excavation and Off-site Disposal

Action	Requirement	Prerequisite	Citation	ARAR Determination			Comments
				A	RA	TBC	
Monitoring	Requires detection monitoring. Once a significant release has occurred, evaluation or corrective action monitoring is required.	Discharge of waste to land after 18 July 1997.	Cal. Code Regs. tit. 27 § 20385 (a)(1) and (a) (2)				Not an ARAR. Not more stringent than federal regulations at Cal. Code Regs. tit. 22 § 66264.91 (see Table B-5 for a comparison of these requirements with parallel Cal. Code Regs. tit. 22 requirements).
Monitoring	Requires specification of COCs for monitoring, reasonably expected to be in or derived from the waste contained in the waste management unit.	Discharge of waste to land after 18 July 1997.	Cal. Code Regs. tit. 27 § 20395				Not an ARAR. Not more stringent than federal regulations at Cal. Code Regs. tit. 22 § 66264.93 (see Table B-5 for a comparison of these requirements with parallel Cal. Code Regs. tit. 22 requirements).
Monitoring	Requires monitoring for compliance with remedial action objectives for 3 years from the date of achieving cleanup levels.	Discharge of waste to land after 18 July 1997.	Cal. Code Regs. tit. 27 § 20410				Not an ARAR. Not more stringent than federal regulations at Cal. Code Regs. tit. 22 § 66264.96 (see Table B-5 for a comparison of these requirements with parallel Cal. Code Regs. tit. 22 requirements).
Monitoring	Requires general soil, surface water, and groundwater monitoring.	Discharge of waste to land after 18 July 1997.	Cal. Code Regs. tit. 27 § 20415				Not an ARAR. Not more stringent than federal regulations at Cal. Code Regs. tit. 22 § 66264.97 (see Table B-5 for a comparison of these requirements with parallel Cal. Code Regs. tit. 22 requirements).
Groundwater Monitoring	Provides minimum requirements for a groundwater detection monitoring program	Discharge of waste to land after 18 July 1997.	Cal. Code Regs. tit. 27 § 20420				Not an ARAR. Not more stringent than federal regulations at Cal. Code Regs. tit. 22 § 66264.98 (see Table B-5 for a comparison of these requirements with parallel Cal. Code Regs. tit. 22 requirements).
Groundwater Monitoring	Requires evaluation monitoring once a significant release is detected.	Discharge of waste to land after 18 July 1997	Cal. Code Regs. tit. 27 § 20425				Not an ARAR. Not more stringent than federal regulations at Cal. Code Regs. tit. 22 § 66264.99 (see Table B-5 for a comparison of these requirements with parallel Cal. Code Regs. tit. 22 requirements).
Corrective Action	Requires implementation of corrective action measures that ensure that cleanup levels are achieved throughout the zone affected by the release by removing the waste constituents or treating them in place. Source control may be required. Also requires monitoring to determine the effectiveness of the corrective actions.	Discharge of waste to land after 18 July 1997	Cal. Code Regs. tit. 27 § 20430				Not an ARAR. Not more stringent than federal regulations at Cal. Code Regs. tit. 22, § 66264.100 (see Table B-5 for a comparison of these requirements with parallel Cal. Code Regs. tit. 22 requirements).
Unsaturated Zone Monitoring		Discharge of waste to land after 18 July 1997	Cal. Code Regs. tit. 27 § 20435				Not an ARAR. Previous radiological investigations at Site 8 have adequately delineated the nature and extent of radiological contamination at Units 1 and 4 (Weston 2000 and Weston 2004b). These studies concluded that the soil contamination at Units 1 and 4 is limited to the shallow soil, and does not pose a threat to groundwater beneath the site. Therefore, no further monitoring for assessment of release is required as a part of remedial action at Site 8, Units 1 and 4.

Table C-4: State Action-Specific ARARs for Remedial Action at Site 8, Units 1 and 4

Remedial Action Alternatives: *Alternative 1* – No Action, *Alternative 2* – Asphalt Cap Plus Institutional Controls and Access Restrictions, *Alternative 3* – Excavation and Off-site Disposal

Action	Requirement	Prerequisite	Citation	ARAR Determination			Comments
				A	RA	TBC	
South Coast Air Quality Management District (SCAQMD)*							
Air emission	Visible emissions standard that states a person shall not discharge any air contaminant into the atmosphere from any single source of emission for a period or periods aggregating more than 3 minutes in a 60-minute period, which is (a) as dark or darker in shade as that designated No. 1 on the Ringelmann Chart, or (b) of such opacity as to obscure an observer's view to a degree equal to or greater than does smoke described in (a).		SCAQMD Rule 401	2, 3			Excavation, grading, earthmoving activities have the potential to produce visible emissions due to fugitive dust. Substantive requirements pertaining to visible emissions, such as wetting the soil may be required to minimize fugitive dust.
	Prohibits discharge of any air emissions in quantities that may cause injury, detriment, nuisance, or annoyance to any considerable number of persons or to the public, or which endanger the comfort, repose, health or safety of any such persons or the public, or which cause, or have a natural tendency to cause, injury or damage to business or property.		SCAQMD Rule 402				Not an ARAR. The DON is troubled by the vague, subjective nature of the nuisance rule and the lack of objective standards, as well as the inclusion of subjective nonenvironmental criteria such as "annoyance, repose, and comfort," and so forth. The requirements of 40 C.F.R. § 300.5 specify that an ARAR must be an environmental or facility siting requirement or limitation. Rule 402 does not fall within the definition of those terms and is therefore not an ARAR. The nature, quantity, and location of identified COPCs at Site 8 should not be of concern. The DON has determined that Rule 402 is not an ARAR for remedial action at Site 8.
	Prohibits a person from building, erecting, installing or using any equipment, the use of which reduces or conceals an emission which would otherwise constitute a violation of these rules or Chapter 3 (starting with 41700) of Part 4, of Division 26 of the Health and Safety Code.		SCAQMD Rule 408				Not an ARAR. Not pertinent to remedial action.
	Limit sulfur compounds from combustion of gaseous fuels not to exceed 40 ppm, 0.05 percent by weight for liquid fuels and 0.56 pounds of sulfur per million BTU for solid fossil fuels.		SCAQMD Rules 431.1, 431.2, 431.3				Not an ARAR. Not pertinent to remedial action.
	Implements the provisions of Part 61, Chapter I, Title 40 of the C.F.R. under the supervision of the Air Quality Management District (AQMD) Executive Officer. It specifies emissions testing, monitoring procedures or handling of hazardous pollutants such as beryllium, benzene, mercury, vinyl chloride and asbestos.		SCAQMD Regulation X				Not an ARAR. Emissions of hazardous pollutants not expected.
	Prohibits initiation of excavation at an active		SCAQMD				Not an ARAR. Not an ARAR. Site 8 is not an active or inactive

Table C-4: State Action-Specific ARARs for Remedial Action at Site 8, Units 1 and 4

Remedial Action Alternatives: *Alternative 1* – No Action, *Alternative 2* – Asphalt Cap Plus Institutional Controls and Access Restrictions, *Alternative 3* – Excavation and Off-site Disposal

Action	Requirement	Prerequisite	Citation	ARAR Determination			Comments
				A	RA	TBC	
	or inactive landfill without an Excavation Management Plan approved by the Executing Officer of AQMD. The plan shall provide information regarding the quantity and characteristics of the material to be excavated and transported and shall identify mitigation measures including gas collection and disposal, baling, encapsulating, covering the material and chemical neutralizing.		Regulation XI, Rule 1150				landfill. Additionally, the requirements are procedural in nature and therefore not ARARs, since only substantive requirements are ARARs for the CERCLA response actions.
	Specifies limits for cancer risk and excess cancer causes from new stationary sources and modifications to existing stationary sources that emit carcinogenic air contaminants. The rule establishes allowable emission impacts for all such stationary sources requiring new permits pursuant to AQMD Rules 201 or 203. Best Available Control Technology for Toxics will be required for any system where a lifetime (70 years) maximum individual cancer risk of one in one million or greater is estimated to occur. Limits are calculated using risk factors for specific contaminants.		SCAQMD Regulation XIV, Rule 1401				Not an ARAR. No new stationary source or modification to existing stationary source emitting carcinogenic pollutants is planned.
	Compiles BACT requirements for various types of equipment or process. BACT is determined on a permit-by-permit basis based on the definition of BACT. In essence, BACT is the most stringent emission limit or control technology that is: ▪ Found in a State Implementation Plan (SIP), or ▪ Achieved in practice, or ▪ Is technically feasible and cost effective For practical purposes, at this time, nearly all AQMD BACT determinations will be based on achieved in practice BACT because it is generally more stringent than BACT based on SIP, and because state law constrains AQMD from using the third approach.		BACT Guidelines document				Not an ARAR. Not an ARAR since the guidance is not promulgated.
California Fish and Game Code*							
Discharge to waters of the State	Prohibits the passage of enumerated substances or materials into waters of the State deleterious to fish, plant life, or birds.		Cal. Fish & Game Code § 5650 (a) & (f)				Not an ARAR. No surface water discharges are expected during the remedial action at Site 8, Units 1 and 4. Additionally BMPs, will be implemented for storm water pollution control.

Table C-4: State Action-Specific ARARs for Remedial Action at Site 8, Units 1 and 4

Remedial Action Alternatives: *Alternative 1* – No Action, *Alternative 2* – Asphalt Cap Plus Institutional Controls and Access Restrictions, *Alternative 3* – Excavation and Off-site Disposal

Action	Requirement	Prerequisite	Citation	ARAR Determination			Comments
				A	RA	TBC	
Actions impacting birds or mammals	Prohibits the taking of birds and mammals, including the taking by poison.		Cal. Fish & Game Code § 3005(a)		2, 3		Procedural aspects are not ARARs; certain substantive provisions pertaining to take of birds or mammals with a poisonous substance are relevant and appropriate. Precautions will be taken during remedial action at Site 8 to prevent bird and mammal exposure to contaminated soil.
Actions impacting rare native plants	Prohibits import, take, and possession of an endangered native plant or rare native plant.		Cal. Fish & Game Code § 1908				Not an ARAR. No endangered or rare native plant species have been identified in the immediate vicinity of Site 8.
Actions impacting endangered species	No person shall import, export, take, possess, or sell any endangered or threatened species or part or product thereof.	Threatened or endangered species determination on or before 01 January 1985 or a candidate species with proper notification.	Cal. Fish & Game Code § 2080				Not an ARAR. No endangered or threatened species have been identified in the immediate vicinity of Site 8.
Actions impacting fur-bearing mammals, game mammals, nongame mammals, protected mammals, or any dog or cat.	Prohibits the use of any body gripping trap and provides that it is unlawful for any person, including an employee of the federal government, to use or authorize the use of such device to capture any game mammal, fur bearing mammal, nongame mammal, protected mammal, or any dog or cat. This prohibition does not apply in the extraordinary case where the use of such device is the only method available to protect human health and safety.		Cal. Fish & Game Code § 3003.1				Not an ARAR. Not pertinent to the scope of remedial action at Site 8.
Actions impacting fully protected bird species/ habitat	Provides that it is unlawful to take or possess any of the fully protected birds, including, American peregrine falcon, Brown pelican, California black rain, California clapper rail, California condor, California least tern, Golden eagle, Greater sandhill crane, Light-footed clapper rail, Southern bald eagle, Trumpeter swan, White-tailed kite, and Yuma clapper rail.		Cal. Fish & Game Code § 3551				Not an ARAR. None of the fully protected bird species have been identified in the vicinity of Site 8.
Actions impacting wetlands	Requires that actions must be taken to assure that there is "no net loss" of wetlands acreage or habitat value, and to preserve, protect, restore and enhance California's wetland acreage and habitat values.		Cal. Fish & Game Commission Wetlands Policy (included in Fish & Game Code Addenda)				Not an ARAR. Since the cited requirement is not promulgated, it is not an ARAR for this remedial action. Additionally, no wetlands have been identified in the vicinity of Site 8 that are expected to be impacted by the remedial action.

Table C-5: Comparison of Monitoring ARARs

Action	California Code of Regulations Title 22	California Code of Regulations Title 27	Controlling ARARs
Monitoring	§ 66264.91(a)(1) Institute a detection monitoring program under § 66264.98 for each unit; (2) institute an evaluation monitoring program under§ 66264.99 whenever there is statistically significant evidence of a release from the regulated unit during a detection monitoring program; or (3) whenever there is significant physical evidence of a release from the regulated unit, including unexplained volumetric changes in surface impoundments, unexplained stress in biological communities, unexplained changes in soil coloration, visible signs of leachate migration, unexplained water table mounding beneath or adjacent to the regulated unit, and any other change to the environment that could reasonably be expected to be the result of a release from the regulated unit; and (4) institute a corrective action program under § 66264.100 when it is determined pursuant to § 66264.99 that the assessment of the nature and extent of the release and the design of the corrective action program have been satisfactorily completed. (b) For each regulated unit, include one or more of the programs identified in subsection (a) of this section in the facility permit as may be necessary to protect human health or the environment and specify the circumstances under which each of the programs will be required. In deciding whether to institute a particular program, consider the potential adverse effects on human health or the environment that might occur before final administrative action on a permit modification application to incorporate such a program could be taken. (c) In conjunction with an evaluation monitoring program or a corrective action program, continue to conduct a detection monitoring program under § 66264.98 as necessary to provide the best assurance of the detection of subsequent releases from the regulated unit.	§ 20385(a)(1) The discharger shall institute a detection monitoring program (under § 20420) for each unit; (2) the discharger shall institute an evaluation monitoring program (under § 20425) whenever there is "measurably significant" evidence of a release from the unit during a detection monitoring program (under § 20420); or (3) whenever there is significant physical evidence of a release from the unit, including unexplained volumetric changes in surface impoundments, unexplained stress in biological communities, unexplained changes in soil characteristics, visible signs of leachate migration, and unexplained water table mounding beneath or adjacent to the unit, and any other change to the environment that could reasonably be expected to be the result of a release from the unit; and (4) the discharger shall institute a corrective action program under § 20430 when the assessment of the nature and extent of the release and the design of a corrective action program has been satisfactorily completed. (b) For each unit, one or more of the programs identified in (a) that are appropriate for the prevailing state of containment at the unit shall be required, and the circumstances will be specified under which each of the programs will be required. In deciding whether to require the discharger to be prepared to institute a particular program, the RWQCB shall consider the potential aerse effects on human health or the environment that might occur before final administrative action on an amended report of waste discharge to incorporate such a program could be taken. (c) In conjunction with an evaluation monitoring program or a corrective action program, the discharger shall continue to conduct a detection monitoring program as necessary to provide the best assurance of the detection of subsequent releases from the unit.	Cal. Code Regs., tit. 22, § 66264.91(a)(1), (2), (3), (4), (b), and (c)
COCs	§ 66264.93 COCs are the waste constituents, reaction products, and hazardous constituents that are reasonably expected to be in or derived from waste contained in the regulated unit.	§ 20395(a) The COC list shall include all waste constituents, reaction products, and hazardous constituents that are reasonably expected to be in or derived from waste contained in the unit.	Cal. Code Regs., tit. 22, § 66264.93
Concentration limits	§ 66264.94(a)(1) and (3) For each COC the owner or operator shall propose for each medium (groundwater, surface water, and the unsaturated zone) monitored a concentration limit not to exceed the background value or a CLGB established for a corrective action program.	20400(a)(1) and (3) For each COC, the discharger shall propose for each medium (including groundwater, surface water, and the unsaturated zone) monitored: a concentration limit not to exceed the background value or a CLGB established for a corrective action program.	Cal. Code Regs., tit. 22, § 66264.94(a)(1) and (3)
	§ 66264.94(c) A concentration limit that is greater than the background value can only be used if demonstrated that it is technologically or economically infeasible to achieve the background value and the COC will not pose a substantial present or potential hazard to human health or the environment.	§ 20400(c) For a corrective action program, a CLGB can be used only if it is technologically or economically infeasible to achieve the background value and it will not pose a substantial present or potential hazard to human health or the environment.	Cal. Code Regs., tit. 22, § 66264.94(c)
	§ 66264.94(d) In establishing a CLGB, the following factors shall be considered: potential adverse effects on groundwater and surface water quality; any identification of underground sources of drinking water; risk being evaluated for groundwater as if exposure would occur at the point of compliance.	§ 20400(d) In establishing a CLGB for a COC, the RWQCB shall consider groundwater and surface water quality.	Cal. Code Regs., tit. 22, § 66264.94(d)

Action	California Code of Regulations Title 22	California Code of Regulations Title 27	Controlling ARARs
Detection monitoring	§ 66264.98(b) and (c) The owner or operator shall install appropriate water quality detection monitoring systems and shall establish a background value in accordance with § 66264.97 for each monitoring parameter and COC.	§ 20420(b) and (c) The discharger shall install appropriate water quality detection monitoring systems and shall establish a background value pursuant to § 20415 for each monitoring parameter and COC.	Cal. Code Regs., tit. 22, § 66264.98(b) and (c)
	§ 66264.98(f) The owner or operator shall conduct sampling and analyses for the monitoring parameters. For groundwater, sampling shall be scheduled to include the times of expected highest and lowest annual elevations of the groundwater surface.	§ 20420(f) The discharger shall monitor for the monitoring parameters listed in the WDRs pursuant to (e).	Cal. Code Regs., tit. 22, § 66264.98(f)
	§ 66264.98(g) In addition to monitoring for the monitoring parameters, the owner or operator shall periodically monitor for all COCs and determine whether there is statistically significant evidence of a release for any COC pursuant to § 66264.97. Monitoring pursuant to this subsection shall be conducted at least every 5 years.	§ 20420(g) In addition to monitoring for the monitoring parameters, the discharger shall periodically monitor for COCs specified in the WDRs, and shall determine whether there is "measurably significant" evidence of a release for any COC pursuant to § 20415. Monitoring pursuant to this paragraph shall be conducted at least every 5 years.	Cal. Code Regs., tit. 22, § 66264.98(g)
	§ 66264.98(i) For each monitoring point, the owner or operator shall determine whether there is statistically significant evidence of a release from the regulated unit for any monitoring parameter.	§ 20420(i) For each monitoring point, the discharger shall determine whether there is "measurably significant" evidence of a release from the unit for any monitoring parameter (or COC).	Cal. Code Regs., tit. 22, § 66264.98(i)
Evaluation monitoring	§ 66264.99(b) The owner or operator shall collect and analyze all data necessary to assess the nature and extent of the release from the regulated unit. This assessment shall include a determination of the spatial distribution and concentration of each COC throughout the zone affected by the release. The owner or operator shall complete and submit this assessment to the Department within 90 days of establishing an evaluation monitoring program.	§ 20425(b) The discharger shall collect and analyze all data necessary to assess the nature and extent of the release from the unit. This assessment shall include a determination of the spatial distribution and concentration of each COC throughout the zone affected by the release. The discharger shall complete and submit this assessment within 90 days of establishing an evaluation monitoring program. For MSW landfills, the discharger shall comply with the additional notification and monitoring system requirements incorporated by reference into SWRCB Res. 93-62, regarding notification and monitoring relative to off-site or potential offsite migration of waste onstituents (see § 258.55[g][1][ii] and [iii] of 40 C.F.R. § 258).	Cal. Code Regs., tit. 22, § 66264.99(b)
	§ 66264.99(c) Based on the data collected pursuant to subsections (b) and (e) of this section, the owner or operator shall update the engineering feasibility study required under § 66264.98(k)(6). The owner or operator shall submit this engineering feasibility study to the Department within 90 days of establishing an evaluation monitoring program.	§ 20425(c) Based on the data collected pursuant to ¶(b) and ¶(e), the discharger shall update the engineering feasibility study for corrective action required pursuant to § 20420(k)(6). The discharger shall submit this updated engineering feasibility study to the RWQCB within 90 days of establishing an evaluation monitoring program.	Cal. Code Regs., tit. 22, § 66264.99(c)
	66264.99(e) The owner or operator shall monitor groundwater, surface water, and the unsaturated zone to evaluate changes in water quality resulting from the release from the regulated unit. (2) The list of monitoring parameters for each medium shall include all hazardous constituents that have been detected in that medium and shall include those physical parameters, waste constituents, and reaction products that provide a reliable indication of changes in water quality resulting from the release from the regulated unit to that medium. (3) The owner or operator shall conduct sampling and analyses for the monitoring parameters. (4) The owner or operator shall periodically monitor for all COCs specified in the facility permit and evaluate changes in water quality due to the release from the regulated unit. The Department shall specify the frequencies for monitoring pursuant to this subsection after considering the degree of certainty associated with the demonstrated correlation between values for monitoring parameters and values for the	§ 20420(e) The discharger shall monitor groundwater, surface water, and the unsaturated zone to evaluate changes in water quality resulting from the release from the unit; (2) the list of monitoring parameters for each medium shall include all hazardous constituents that have been detected in that medium and those physical parameters, waste constituents, and reaction products that provide a reliable indication of changes in water quality resulting from any release from the unit to that medium; (3) the discharger shall monitor for the monitoring parameters listed; (4) in addition to monitoring for the monitoring parameters specified pursuant to (e)(3), at least every 5 years, the discharger shall periodically monitor for all COCs specified in the WDRs to evaluate changes in water quality due to the release from the unit. The discharger shall use data analysis methods for conducting data analyses that comply with § 20415 for evaluating changes in water quality due to the elease from the unit; (5) the discharger shall maintain a record of water quality analytical data as measured and in a form necessary for the evaluation of	Cal. Code Regs., tit. 22, § 66264.99(e)

Action	California Code of Regulations Title 22	California Code of Regulations Title 27	Controlling ARARs
Evaluation Monitoring *(Continued)*	COCs. (5) The owner or operator shall maintain a record of water quality analytical data as measured and in a form necessary for the evaluation of changes in water quality due to the release from the regulated unit.	changes in water quality due to a release from the unit.	
	§ 66264.99(f) If the owner or operator demonstrates to the satisfaction of the Department that a source other than the regulated unit caused the evidence of a release or that the evidence is an artifact caused by an error in sampling, analysis, or statistical evaluation, or by natural variation in groundwater, surface water, or the unsaturated zone, the owner or operator shall submit an application for a permit modification to reinstitute a detection monitoring program meeting the requirements of § 66264.98. This application shall include specifications for all appropriate changes to the monitoring program.	§ 20425(f) The discharger may demonstrate that a source other than the unit caused the evidence of a release or that the evidence is an artifact caused by an error in sampling, analysis, or statistical evaluation, or by natural variation in groundwater, surface water, or the unsaturated zone. Upon a successful demonstration, the RWQCB shall specify that the discharger shall reinstitute a detection monitoring program meeting the requirements of § 20420.	Cal. Code Regs., tit. 22, § 66264.99(f)
	§ 66264.99(g) Interim corrective action measures shall be required where necessary to protect human health or the environment.	§ 20425(g) Interim corrective action measures shall be required where necessary to protect human health or the environment.	Cal. Code Regs., tit. 22, § 66264.99(g)
Corrective action monitoring	§ 66264.100(b) The owner or operator shall take corrective action to remediate releases from the regulated unit and to ensure that the regulated unit achieves compliance with the water quality protection standard.	§ 20430(b) The discharger shall take corrective action to achieve the following goals: to remediate releases from the unit; to ensure that the discharger achieves compliance with the Water Standard.	Cal. Code Regs., tit. 22, § 66264.100(b)
	§ 66264.100(c) The owner or operator shall implement corrective action measures that ensure that COCs achieve their respective concentration limits at all monitoring points and throughout the zone affected by the release, including any portions of the affected zone that extend beyond the facility boundary, by removing the waste constituents or treating them in place. The owner or operator shall take other action to prevent noncompliance due to a continued or subsequent release including but not limited to source control.	§ 20430(c) The discharger shall implement corrective action measures that ensure that COCs achieve their respective concentration limits at all monitoring points and throughout the zone affected by the release, including any portions thereof that extend beyond the facility boundary, by removing the waste constituents or treating them in place. The discharger shall take other action to prevent noncompliance due to a continued or subsequent release from the unit, including but not limited to source control.	Cal. Code Regs., tit. 22, § 66264.100(c)
	§ 66264.100(g)(1) Compliance "demonstration shall be based on the results of sampling and analysis for all constituents of concern for a period of one year."	§ 20430(g)(1) For compliance demonstration each "must have remained at or below its respective concentration limit during a proof period of at least one year . . . and . . . (2) each Monitoring Point must have been evenly distributed throughout the proof period and have consisted of no less than eight sampling events per year per Monitoring Point."	Cal. Code Regs., tit. 22, § 66264.100(g) (1); Cal. Code Regs., tit. 23, § 2550.10(g)(2); and Cal. Code Regs tit. 27, § 20430(g)(2)

5. REFERENCES

Bechtel National, Inc. (BNI). 1997a. *Draft Phase II Feasibility Study, OU-3A Sites, Marine Corps Air Station, El Toro, California*. San Diego: NFECSW SDIEGO. July.

———. 1997b. *Draft Final Phase II Remedial Investigation Report, OU-3A Sites, Marine Corps Air Station, El Toro, California*. San Diego, CA: NAVFAC EFD SOUTHWEST. March.

Department of the Navy, United States (DON). 1999. *Draft Record of Decision, Operable Unit 3A, Sites 8, 11, and 12, Marine Corps Air Station, El Toro, California*. San Diego: NFECSW SDIEGO. June.

Earth Tech, Inc. (Earth Tech). 2003. *Technical Memorandum, Reevaluation of Risk, IRP Sites 8, 11, and 12, Marine Corps Air Station, El Toro, California*. Pearl Harbor, Hawaii: NFECP PEARL. February.

Environmental Protection Agency, United States (EPA). 1997. *EPA Memorandum: Establishment of Cleanup Levels for CERCLA Sites with Radioactive Contamination*. Washington, DC: Stephen D. Luftig, Office of Emergency and Remedial Response; Larry Weinstock, Office of Radiation and Indoor Air. OSWER no. 9200.4-18. August 22.

Jacobs Engineering Group, Inc. (JEG). 1993. *Marine Corps Air Station El Toro: Installation Restoration Program, Phase I Remedial Investigation, Draft Technical Memorandum*.

Roy F. Weston (Weston). 2001. *MCAS El Toro Radiological Survey Plan*. January.

———. 2003. *Draft Radiological Sampling Amendment to Marine Corps Air Station El Toro Radiological Survey Plan*. October.

———. 2004a. *Draft Radiological Release Report, IRP Site 8 – (Units 2, 3, & 5), IRP Site 12, and IRP Site 25 (Bee Canyon Wash Outfall), Former Marine Corps Air Station (MCAS) El Toro*. July.

———. 2004b. *Radiological Data Package for Site 8, Units 1 and 4, Former Marine Corps Air Station (MCAS) El Toro, CA*. Vallejo, CA. Provided to Earth Tech on August 03.

United States Environmental Protection Agency (U.S. EPA). 1988a. *CERCLA Compliance With Other Laws Manual, Draft Guidance*. EPA/540/G-89/006, Office of Emergency and Remedial Response, Washington, DC. August.

———. 1988b. *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA*. OSWER Directive 9355.3-01, -02. EPA/540/G-89/004. October.

———. 1997. *Establishment of Cleanup Levels for CERCLA Sites with Radioactive Contamination* Memorandum from Stephen Luftig (Office of Emergency and Remedial Response) and Larry Weinstock (Office of Radiation and Indoor Air). OSWER Directive 9200.4-18. August.

———. 1998. *Use of Soil Cleanup Criteria in 40 CFR Part 192 as Remediation Goals for CERCLA Sites*. Memorandum from Stephen Luftig (Office of Superfund Remediation Technology Innovation) and Larry Weinstock (Office of Radiation and Indoor Air). OSWER Directive 9200.4-25. February.

———. 2000. *Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM), Revision 1*. NUREG-1575; Rev.1, EPA/402/R-97/016 Rev. 1; DOE/EH-0624, Rev.1. August.

United States Nuclear Regulatory Commission (NRC). 1997a. *A Nonparametric Statistical Methodology for the Design and Analysis of Final Status Decommissioning Surveys*. Division of Regulatory Compliance, Office of Nuclear Regulatory Research. Washington, DC. July.

United States Nuclear Regulatory Commission (NRC). 1997b. *Minimum Detectable Concentrations with Typical Radiation Survey Instruments for Various Contaminants and Field Conditions*. Washington, DC. December.

Attachment A
Correspondence – State ARAR Identification

California Regional Water Quality Control Board
Santa Ana Region

Terry Tamminen
Secretary for
Environmental
Protection

3737 Main Street, Suite 500, Riverside, California 92501-3348
(909) 782-4130 • Fax (909) 781-6288
http://www.swrcb.ca.gov/rwqcb8

Arnold Schwarzenegger
Governor

June 30, 2004

Base Realignment and Closure
Attn: Mr. F. Andrew Piszkin, P.E.
BRAC Environmental Coordinator
7040 Trabuco Road
Irvine, CA 92618

REQUEST FOR REGIONAL WATER QUALITY CONTROL BOARD (RWQCB) APPLICABLE RELEVANT AND APPROPRIATE REQUIREMENTS (ARARs), FOR IRP SITE 8, DEFENSE REUTILIZATION AND MARKETING OFFICE STORAGE AREA, AND IRP SITE 12, SLUDGE DRYING BEDS, AT FORMER MARINE CORPS AIR STATION, EL TORO

Dear Mr. Piszkin:

On May 27, 2004 we received your request that the Santa Ana RWQCB provide any additional ARARS for Sites 8 and 12 at MCAS El Toro in compliance with Section 121(d) of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). We submit the following to you as ARARS for Sites 8 and 12:

Water Quality Order No. 99-08-DWQ and the NPDES General Permit for Storm Water Discharges Associated with Construction Activity (General Permit)

Citation: 40 Code of Federal Regulations parts 122, 123, 124 National Pollution Discharge Elimination System

Description: Construction and earth-moving activities that result in disturbances of at least one acre are subject to this permit. Such activities include, but are not limited to, clearing, grading, stockpiling and excavation of soil or other materials

ARARs Status: Applicable, Action

Title 27, California Code of Regulations

Citation: § 20200 and § 20210

received 7/5/04

Description: Requires that designated waste be discharge to Class I or II waste management units.

Comments: Applies to discharges of designated waste (nonhazardous waste that could cause degradation of surface or groundwaters) to land for treatment, storage, or disposal.

ARARs status: Applicable, Action, Chemical

Citation: § 21400

Description: Requires surface impoundments to be closed by removing and treating all free liquid and either removing all remaining contamination or closing the surface impoundment as a landfill.

Comments: This applies to the sludge drying beds at IRP 12.

ARARs Status: Applicable, Action

Citation: § 20385 – 20435

Description: Groundwater monitoring

Comments: Applies to all areas in which waste has been discharged to land to determine the threat to water quality.

ARARs Status: Applicable, Action

Citation: § 20400 (Title 23, CCR Section 2550.7)

Description: Cleanup levels must be set at background concentration levels, or if background concentration levels are not technologically and economically feasible, then at the lowest levels that are economically and technologically feasible.

Comments: Applies to IRP 8 and 12. If water quality is threatened, this section applies in setting soil cleanup levels for all cleanups of discharges of wastes to land.

ARARs status: Applicable, Chemical, Action

Citation: § 20415

Description: Require general soil, surface water, and groundwater monitoring

Comments: Applies to IRP Sites 8 and 12. Applies to all areas in which waste was discharged to land.

ARARs Status: Applicable, Action

If you should have any questions, please call me at (909) 782-4494 or send e-mail to jbroderic@rb8.swrcb.ca.gov.

Sincerely,

John Broderick
SLIC/DoD Section

cc via e-mail: Ms. Nicole Moutoux, US EPA Region 9
Mr. Tayseer Mahmoud, DTSC, Office of Military Facilities
Mr. Karnig Ohannessian, NAVFACENGCOM, Southwest Division

Department of Toxic Substances Control

Edwin F. Lowry, Director
5796 Corporate Avenue
Cypress, California 90630

Terry Tamminen
Agency Secretary
Cal/EPA

Arnold Schwarzenegger
Governor

June 30, 2004

Mr. F. Andrew Piszkin
BRAC Environmental Coordinator
Base Realignment and Closure
Marine Corps Air Station El Toro
7040 Trabuco Road
Irvine, California 92618

REQUEST FOR IDENTIFICATION OF APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARARS) FOR SITES 8 AND 12 AT THE FORMER MARINE CORPS AIR STATION (MCAS) EL TORO, CALIFORNIA

Dear Mr. Piszkin:

This letter transmits the potential state ARARs the Navy requested in the preparation of a Removal Action Plan (RAP) for Sites 8 and 12 at the former MCAS El Toro. At this time, we are forwarding the enclosed ARARs received from the following agencies:

- California Department of Health Services
- California Department of Fish and Game
- Air Resources Board
- South Coast Air Quality Management District
- California Department of Transportation

DTSC will forward any additional ARARs if received from non-responding agencies at a later date. As you already know, the ARAR analysis is an iterative process and when the remedial alternatives are more fully developed in the RAP, certain ARARs may no longer apply or additional ARARs may become apparent.

received
7/5/04

DTSC looks forward to working closely with the Navy on the remediation at the former MCAS El Toro. If you have any question, please call me at (714) 484-5419.

Sincerely,

Tayseer Mahmoud
Senior Hazardous Substances Engineer
Office of Military Facilities
Southern California Operations Branch

Enclosures

cc: Ms. Nicole Moutoux
Remedial Project Manager
U. S. Environmental Protection Agency Region IX
Superfund Division (SFD-8-1)
75 Hawthorne Street
San Francisco, California 94105-3901

Mr. John Broderick
Remedial Project Manager
California Regional Water Quality Control Board
Santa Ana Region
3737 Main Street, Suite 500
Riverside, California 92501-3348

Ms. Content Arnold
Remedial Project Manager
Naval Facilities Engineering Command
Southwest Division - Code 06CC.CA
1220 Pacific Highway
San Diego, California 92132-5187

Mr. Robert Woodings
Restoration Advisory Board Co-chair
23161 Lake Center Drive, Suite 100
Lake Forest, California 92630

cc: Ms. Marcia Rudolph
Restoration Advisory Board Subcommittee Chair
24922 Muirlands #139
Lake Forest, California 92630

Ms. Polin Modanlou
County of Orange
Planning and Development Services Department
300 North Flower Street, 3rd Floor
Santa Ana, California 92703

Mr. Steven Sharp
Orange County Health Care Agency
2009 East Edinger Avenue
Santa Ana, California 92705

State of California Department of Health Services

Memorandum

Date June 3, 2004

To: Mr. Tayseer Mahmoud
Department of Toxic Substances Control (DTSC)
Office of Military Facilities
5796 Corporate Avenue
Cyprus, California 90630

From: Environmental Management Branch
P.O. Box 997413, MS 7405
1616 Capitol Avenue
Sacramento, California 95899-7413

Subject: Request for Applicable or Relevant and Appropriate Requirements (ARARs) for Sites 8 and 12, of the former Marine Corps Station, El Toro, California

This is in response to your request, dated May 20, 2004, for Applicable or Relevant and Appropriate Requirements (ARARs) for the former Marine Corps Station, El Toro.

As an Agreement State with the Nuclear Regulatory Commission (NRC), California licenses and monitors compliance of byproduct materials use as defined by the Atomic Energy Act of 1954. In addition, the Department of Health Services (DHS) controls the uses of naturally occurring radioactive materials (e.g. radium-226). DHS regulatory authority does not include the licensing and compliance monitoring of facilities under exclusive federal jurisdiction. This is the NRC's responsibility. DHS becomes involved when a federal facility (e.g. a military base) is going to close and revert to State control. We are currently providing radiological consultation for closing military bases in California in preparation for the bases being transferred into State, local or private ownership.

Listed below are the regulations, statutes and guidance that pertain to radioactive materials found on military bases in California.

1. Title 10, Code of Federal Regulations (CFR), Sections 20.1001-2402 and Appendices A through F, as incorporated by reference to Title 17, California Code of Regulations (CCR), Section 30253. A significant change in the regulations, as adopted by California, is that the federal term "licensee" is replaced by "user" as defined in Title 17, CCR, Section 30100.

2. Title 10, Code of Federal Regulations (CFR), Sections 20.1402 and 20.1404, Radiological Criteria for License Termination; Final Rule.

3. Relevant guidance documents published by the Nuclear Regulatory Commission (NRC) (e.g. NUREG/CR - 5849).

If you have questions about DHS' ARARs or their applications to this base, please contact me at (916) 449-5664.

Deirdre Dement
for

Darice Bailey, Chief
Waste Management Section

cc: Mr. F. Andrew Piszkin
Department of the Navy
Southwest Division
Naval Facilities Engineering Command
1220 Pacific Highway
San Diego, CA 92132-5190

State of California

Memorandum

To: Mr. Tayseer Mahmoud
Senior Hazardous Substances Engineer
Office of Military Facilities
Department of Toxic Substances Control
5796 Corporate Avenue
Cypress, CA 90630

Date: June 16, 2004

From: Regina Donohoe, Ph.D.
Staff Toxicologist
Office of Spill Prevention and Response
Department of Fish and Game

Subject: **Applicable or Relevant and Appropriate Requirements (ARARs) for Sites 8 and 12 -- Former Marine Corps Air Station (MCAS) El Toro, California**

This memo is in response to your June 2, 2004, memorandum requesting potential State Applicable or Relevant and Appropriate Requirements (ARARs), to-be-considered (TBC) criteria, advisories, guidance or proposed standards that may apply in the preparation of an Action Memorandum for Site 8 and Site12 at the Former MCAS El Toro. The Department of Fish and Game, Office of Spill Prevention and Response (DFG-OSPR) appreciates this opportunity to provide State laws and regulations to guide the planned remediation at these sites.

DFG-OSPR is providing the following analysis pursuant to Section 121(d)(2)(A) of the Comprehensive Environmental Response, Compensation, and Liability Act and under the National Contingency Plan (NCP), 40 Code of Federal Regulations section 300.400(g) and 300.515(d) and (h).

Sites 8 and 12 are located in the southwest portion of the former MCAS, El Toro in Orange County, California. Site 8 was formerly a Defense Reutilization and Marketing Office and was used as a storage area for containerized liquids and salvage materials. Site 12, designated as the Sludge Drying Beds, consists of sludge drying beds, a drainage ditch and former wastewater treatment plants. According to Frank Cheng, DTSC (personal communication on June 8, 2004), the remedial investigations noted the absence of significant plant and wildlife habitat, negating the need to conduct ecological risk assessments at Sites 8 and 12. However, the May 20, 2004 letter from the Department of Navy, attached to your June 2, 2004 memorandum, did not provide a description of the habitats at and around these sites. Therefore, in the absence of this site-specific information, we are including an inclusive list of potential ARARs. This list may be further refined as additional information on the habitat at and around these sites is provided.

Listed on the enclosed table is a site-specific list of Fish and Game Code Sections which may apply as State ARARs or TBCs with the date of enactment or

promulgation. The specific citation and explanation for each listed ARAR and TBC are also enclosed, in addition to applicable statutes and regulations.

We would like to reiterate our interest in coordinating any natural resource issues should there be a release(s) of any hazardous/deleterious materials at the MCAS El Toro that could affect the State's natural resources. The staff of the DFG-OSPR appreciates the opportunity to provide our ARARs. If you have any questions or need further information, please contact me at (831) 649-7150 or by e-mail at rdonohoe@ospr.dfg.ca.gov.

Reviewer: Julie Yamamoto, Ph.D., Senior Toxicologist
Wendy Johnson, Staff Counsel

Enclosure

cc:
Department of Fish and Game
Office of Spill Prevention and Response
Julie Yamamoto, CDFG/OSPR-Scientific
Wendy Johnson, CDFG/OSPR-Legal

CALIFORNIA DEPARTMENT OF FISH AND GAME
LOCATION AND ACTION SPECIFIC ARARs AND TBCs FOR MCAS El TORO SITES 8 AND 12

LOCATION	STANDARD	SPECIFIC CITATION	ARAR/TBC EXPLANATION
Aquatic habitat/species	Action must be taken if toxic materials are placed where they can enter waters of the State. There can be no release that would have a deleterious effect on species or habitat.	Fish and Game Code section 5650 (a), (b) & (f)	This code section prohibits depositing or placing where it can pass into waters of the state any petroleum products (Section 5650(a)(1)), factory refuse (section 5650(a)(4)), sawdust, shavings, slabs or edgings (section 5650(a)(3)), and any substance deleterious to fish, plant life or bird life (section 5650(a)(6)). These are substantive, promulgated environmental protection requirements. These requirements impose strict criminal liability on violators. (*People v. Chevron Chemical Company (1983) 143 Cal. App. 3d 50).* This imposition of strict criminal liability imposes a standard that is more stringent than federal law. The extent to which each subdivision of section 5650 is relevant and appropriate depends on the site characterization.
Wildlife Species	Action must be taken to prohibit the taking of birds and mammals, including the taking by poison	Fish and Game Code section 3005 (Stats. 1957, c. 456, p. 1353 section 3005)	This code section prohibits the taking of birds and mammals, including taking by poison. "Take" is defined by Fish and Game Code section 86 to include killing. "Poison" is not defined in the code. Although there is no state authority on this point, federal law recognizes that poison, such as Strychnine, may affect incidental taking. (*Defenders of Wildlife v. Administrator, Environmental Protection Agency (1989) 882. F. 2d. 1295).* This code section imposes a substantive, promulgated environmental protection requirement.

CALIFORNIA DEPARTMENT OF FISH AND GAME
LOCATION AND ACTION SPECIFIC ARARs AND TBCs FOR MCAS El TORO SITES 8 AND 12

LOCATION	STANDARD	SPECIFIC CITATION	ARAR/TBC EXPLANATION
Rare native plants	Action must be taken to conserve native plants, there can be no releases and/or actions that would have a deleterious effect on species or habitat.	Fish and Game Code section 1908 (Added by Stats. 1977, c. 1181, p. 3869, section 8)	These code sections make provisions concerning native plants protection, including: criteria for determining endangered plant species; designation of endangered plants by the Fish and Game Commission; research by the Department; takings by the Department for scientific or propagation purposes; other prohibitions on takings; exercise of enforcement authority; arrests and confiscation; carrying out of plant conservation programs by other state departments and agencies; and unauthorized public agency regulations pertaining to agriculture. Section 1908 imposes a substantive requirement by forbidding any "person" to take rare or endangered native plants. Fish and Game Code section 67 provides the definition of "person" as any natural person or any partnership, corporation, limited liability company, trust, or other type of association. Whether the federal government or contractors acting on behalf of the federal government would fall within that definition is a potential issue. To the extent that there are rare or endangered plants on site, section 1908 would be an ARAR.

CALIFORNIA DEPARTMENT OF FISH AND GAME
LOCATION AND ACTION SPECIFIC ARARs AND TBCs FOR MCAS El TORO SITES 8 AND 12

LOCATION	STANDARD	SPECIFIC CITATION	ARAR/TBC EXPLANATION
Endangered Species	Action must be taken to conserve endangered species, there can be no releases and/or actions that would have a deleterious effect on species or habitat.	Fish and Game Code section 2080 (Added by Stats. 1984, c. 1240, section 2).	This section prohibits the take, possession, purchase or sell within the state, any species (including rare native plant species), or any product thereof, that the commission determines to be an endangered or threatened species, or the attempt of any of these acts. This section is applicable and relevant to the extent that there are endangered or threatened species in the area which have the potential of being affected if actions are not taken to conserve the species. This section prohibits releases and/or actions that would have a deleterious effect on species or their habitat. This section and applicable Title 14 regulations should be considered as ARARs. *California Code of Regulations Title 14 sections 670.2* provides a listing the plants of California declared to be Endangered, Threatened or Rare. *California Code of Regulations Title 14 section 670.5* provides a listing of Animals of California declared to be endangered or threatened. *California Code of Regulations Title 14 section 783 et. seq.*, provides the implementation regulations for the California Endangered Species Act.

CALIFORNIA DEPARTMENT OF FISH AND GAME
LOCATION AND ACTION SPECIFIC ARARs AND TBCs FOR MCAS El TORO SITES 8 AND 12

LOCATION	STANDARD	SPECIFIC CITATION	ARAR/TBC EXPLANATION
Wildlife/ domestic species	Action must be taken to prohibit the use of steel-jawed leghold traps	Fish and Game Code section 3003.1 (Prop. 4 section 1 approved Nov. 3, 1998, eff. Nov. 4, 1998)	This section prohibits the use of any body gripping trap and provides that it is unlawful for any person, including an employee of the federal government, to use or authorize the use of such device to capture any game mammal, fur bearing mammal, nongame mammal, protected mammal, or any dog or cat. This prohibition will not apply in the extraordinary case where the use of such a device is the only method available to protect human health and safety.

CALIFORNIA DEPARTMENT OF FISH AND GAME
LOCATION AND ACTION SPECIFIC ARARs AND TBCs FOR MCAS El TORO SITES 8 AND 12

LOCATION	STANDARD	SPECIFIC CITATION	ARAR/TBC EXPLANATION
Fully protected bird species/habitat	Action must be taken to prevent the taking of fully protected birds	Fish and Game Code section 3511 (Added by Stats.1970, c. 1036, p. 1848 section 4)	This section provides that it is unlawful to take or possess any of the following fully protected birds: (a). American peregrine falcon (b). Brown Pelican (c). California black rail (d). California clapper rail (e). California condor (f). California least tern (g). Golden eagle (h). Greater sandhill crane (i). Light-footed clapper rail (j). Southern bald eagle (k). Trumpeter swan (l). White-tailed kite (m). Yuma clapper rail This should be considered Applicable and Relevant to the extent that such fully protected birds or their habitat are detected on or near the site.

CALIFORNIA DEPARTMENT OF FISH AND GAME
LOCATION AND ACTION SPECIFIC ARARs AND TBCs FOR MCAS El TORO SITES 8 AND 12

LOCATION	STANDARD	SPECIFIC CITATION	ARAR/TBC EXPLANATION
Wetlands	Actions must be taken to assure that there is "no net loss" of wetlands acreage or habitat value. Action must be taken to preserve, protect, restore and enhance California's wetland acreage and habitat values.	Fish and Game Commission Wetlands Policy (adopted 1987) included in Fish and Game Code Addenda	This policy seeks to provide for the protection, preservation, restoration, enhancement and expansion of wetland habitat in California. Further, it opposes any development or conversion of wetland that would result in a reduction of wetland acreage or habitat value. It adopts the USFWS definition of a wetland which utilizes hydric soils, saturation or inundation, and vegetable criteria, and requires the presence of at least one of these criteria (rather than all three) in order to classify an area as a wetland. This policy is not a regulatory program and should be included as a TBC.

CALIFORNIA DEPARTMENT OF FISH AND GAME
LOCATION AND ACTION SPECIFIC ARARs AND TBCs FOR MCAS El TORO SITES 8 AND 12

LOCATION	STANDARD	SPECIFIC CITATION	ARAR/TBC EXPLANATION
Fully Protected Mammals	Actions must be taken to assure that no fully protected mammals are taken or possessed at any time.	Fish and Game Code section 4700 (Added by Stats. 1970, c. 1036, p. 1848 section 6)	This section prohibits the take or possession of any of the fully protected mammals or their parts. The following are fully protected mammals: (a) Morro Bay kangaroo rat (b) Bighorn sheep except Nelson bighorn sheep (c) Northern elephant seal (d) Guadalupe fur seal (e) Ring-tailed cat (f) Pacific right whale (g) Salt-marsh harvest mouse (h) Southern sea otter (i) Wolverine This section is applicable, relevant, and appropriate to the extent that such mammals and/or their habitat are located on or near the site.

CALIFORNIA DEPARTMENT OF FISH AND GAME
LOCATION AND ACTION SPECIFIC ARARs AND TBCs FOR MCAS El TORO SITES 8 AND 12

LOCATION	STANDARD	SPECIFIC CITATION	ARAR/TBC EXPLANATION
Fully Protected Reptiles and Amphibians	Actions must be taken to prevent the take or possession of any fully protected reptile or amphibian.	Fish and Game Code section 5050 (Added by Stats. 1970, c. 1036, p. 1849, section 7)	This section prohibits the take or possession of fully protected reptiles and amphibians or parts thereof. The following are fully protected reptiles and amphibians: (1) Blunt-nosed leopard lizard (2) San Francisco garter snake (3) Santa Cruz long-toed salamander (4) Limestone salamander (5) Black toad This section is applicable, relevant and appropriate to the extent that these amphibians or reptiles and/or their habitat are located on or near the site.
Birds	Action must be taken to avoid the take or destruction of the nest or eggs of any bird	Fish and Game Code section 3503	This section prohibits the take, possession, or needless destruction of the nest or eggs of any bird, except as otherwise provided by this code or any regulation made pursuant thereto.

CALIFORNIA DEPARTMENT OF FISH AND GAME
LOCATION AND ACTION SPECIFIC ARARs AND TBCs FOR MCAS El TORO SITES 8 AND 12

LOCATION	STANDARD	SPECIFIC CITATION	ARAR/TBC EXPLANATION
Birds of Prey	Action must be taken to prevent the take, possession, or destruction of any birds of prey or their eggs	Fish and Game Code section 3503.5 (Added by Stats. 1985, c. 1334, section 6)	This section prohibits the take, possession, or destruction of any birds in the orders of Falconiformes or Strigiformes (birds-of-prey) or to take, possess, or destroy the nest or eggs of any such bird except as otherwise provided by this code or any regulation adopted pursuant thereto. This section will be applicable and relevant to the extent that such species or their eggs are located on or near the site.
Nongame birds	Actions must be taken to prevent the take of nongame birds.	Fish and Game Code section 3800 (Added by Stats. 1971, c. 1470, p. 2906, section 13)	This section prohibits the take of nongame birds, except in accordance with regulations of the commission, or when related to mining operations with a mitigation plan approved by the department. This section further provides requirements concerning mitigation plans related to mining. This section is applicable and relevant to the extent that nongame birds or their eggs are located on or near the site and such species have not been included in the fish and wildlife conservation plan filed pursuant to the Federal Fish and Wildlife Conservation Act. Species included in the plan will be protected at the federal standard making this section an ARAR to the extent that it is more stringent than the federal standard of protection.

CALIFORNIA DEPARTMENT OF FISH AND GAME
LOCATION AND ACTION SPECIFIC ARARs AND TBCs FOR MCAS El TORO SITES 8 AND 12

LOCATION	STANDARD	SPECIFIC CITATION	ARAR/TBC EXPLANATION
Fur-bearing mammals	Provides manners under which fur-bearing mammals may be taken	Fish and Game Code section 4000, et. Seq. (Stats. 1957, c. 456, p. 1380, section 4000)	This section provides that a fur-bearing mammal may be taken only with a trap, a firearm, bow and arrow, poison under a proper permit, or with the use of dogs.
Nongame mammals	Action must be taken to avoid the take or possession of nongame mammals	Fish and Game Code section 4150 (Added by Stats. 1971, c. 1470, p. 2907, section 21)	Nongame mammals are those occurring naturally in California which are not game mammals, fully protected mammals, or fur-bearing mammals. These mammals, or their parts, may not be taken or possessed except as provided in this code or in accordance with regulations adopted by the commission.

CALIFORNIA DEPARTMENT OF FISH AND GAME
LOCATION AND ACTION SPECIFIC ARARs AND TBCs FOR MCAS El TORO SITES 8 AND 12

LOCATION	STANDARD	SPECIFIC CITATION	ARAR/TBC EXPLANATION
Nongame Animals	Action must be taken to avoid the take of nongame mammals except as provided in applicable regulations	Title 14 California Code of Regulations (hereinafter referred as C.C.R.) section 472 (effective 07/01/74)	This Regulation provides that nongame birds and mammals may not be taken except as provided in subsections (a) through (d) below and in Sections 478 and 485. a). The following nongame birds and mammals may be taken except as provided in Chapter 6: English Sparrow, starling, coyote, weasels, skunks, opossum, moles and rodents (excludes tree and flying squirrels, and those listed as furbearers, endangered or threatened species); b). Fallow, sambar, sika, and axis deer may be taken concurrently with the general deer season. c). Aoudad, mouflon,tahr, and feral goats may be taken all year. d). American crows may be taken only under provisions of section 485 and by landowners or tenants, or person authorized by landowners or tenants, when American crows are committing or about to commit depredations upon ornamental shade trees, agricultural crops, livestock, or wildlife, or when concentrated in such numbers and manner as to constitute a health hazard or other nuisance. If required by Federal regulations, landowners or tenants shall obtain a Federal migratory bird depredation permit before taking any American crows or authorizing any other person to take them.

CALIFORNIA DEPARTMENT OF FISH AND GAME
LOCATION AND ACTION SPECIFIC ARARs AND TBCs FOR MCAS El TORO SITES 8 AND 12

LOCATION	STANDARD	SPECIFIC CITATION	ARAR/TBC EXPLANATION
Nongame Birds and NonGame Mammals	Methods of Take	Title 14 C.C.R. section 475 (effective 07/05/72)	This regulation provides that birds and nongame mammals may be taken in any manner except as follows: a). Poison may not be used, b). Recorded or electrically amplified bird or mammal calls or sounds or recorded or electrically amplified imitations of bird or mammal calls or sounds may not be used to take any nongame bird or nongame mammal except coyotes, bobcats, American crows and starlings, c). Traps may be used in very limited situations, and d). No feed, bait or other substance capable of attracting a nongame mammal may be used in conjunction with dogs.
Bear	License requirements to take bear	Fish and Game Code section 4750 (Added by Stats. 1957, c. 1916, p. 3349, section 2)	This section makes it unlawful to take any bear with firearm, trap, or bow and arrow without first procuring a license tag authorizing the take of the bear, this section further provides that no iron or steel-jawed or any type of metal-jawed trap shall be used to take any bear.
Specially Protected Mountain Lion	Action must be taken to avoid injuring, taking, possessing or transporting any mountain lion.	Fish and Game Code sections 4800 et.seq. (Prop. 117 approved June 5, 1990)	Mountain lions are specially protected mammals in California. It is unlawful to take, injure, possess, transport, or sell any mountain lion or any part or product thereof. Violation of this section is a misdemeanor.

CALIFORNIA DEPARTMENT OF FISH AND GAME
LOCATION AND ACTION SPECIFIC ARARs AND TBCs FOR MCAS El TORO SITES 8 AND 12

LOCATION	STANDARD	SPECIFIC CITATION	ARAR/TBC EXPLANATION
Protected Amphibians	Action must be taken to avoid the take or possession of protected amphibians.	Title 14 C.C.R. sections 40 (Section 40 designated effective 03/01/74)	This regulation makes it unlawful to capture, collect, intentionally kill or injure, possess, purchase, propagate, sell, transport, import, or export any native reptile or amphibian, or parts thereof unless under special permit from the department issued pursuant to Title 14 C.C.R. sections 650, 670.7, or 783 of these regulations, or as otherwise provided in the Fish and Game Code or these regulations.
Furbearing Mammals	Action must be taken to avoid take	Title 14 C.C.R. section 460 (effective 07/01/59)	Regulation makes it unlawful to take Fisher, marten, river otter, desert kit fox, and red fox.
Furbearing Mammals	Provides methods of take for other furbearing mammals not listed in Title 14 C.C.R. section 460	Title 14 C.C.R. section 465 (effective 07/01/69)	Furbearing mammals may be taken only with a firearm, bow and arrow, or with the use of dogs, or traps in accordance with the provisions of Section 465.5 of Title 14 and section 3003.1 of the Fish and Game Code.

CALIFORNIA DEPARTMENT OF FISH AND GAME
LOCATION AND ACTION SPECIFIC ARARs AND TBCs FOR MCAS El TORO SITES 8 AND 12

LOCATION	STANDARD	SPECIFIC CITATION	ARAR/TBC EXPLANATION
Fully Protected Fish	Actions must be taken to prevent the take or possession of any fully protected fish species.	Fish and Game Code section 5515 (Added by Stats. 1970, c. 1036, p. 1849, section 8)	This section prohibits the take or possession of fully protected fish or parts thereof. The following are fully protected fish: (a) Colorado River squawfish (b) Thicktail chub (c) Mohave chub (d) Lost River sucker (e) Modoc sucker (f) Shortnose sucker (g) Humpback sucker (h) Owens River pupfish (i) Unarmored threespine stickleback (j) Rough sculpin This section is applicable, relevant and appropriate to the extent that such fish species or their habitat are located on or near the Site.

Terry Tamminen
Agency Secretary

Air Resources Board

Alan C. Lloyd, Ph.D.
Chairman
1001 I Street • P.O. Box 2815
Sacramento, California 95812 • www.arb.ca.gov

Arnold Schwarzenegger
Governor

MEMORANDUM

TO: Tayseer Mahmoud
Senior Hazardous Substances Engineer
Southern California Branch
Office of Military Facilities
Department of Toxic Substances Control
5796 Corporate Avenue
Cypress, California 90630

FROM: Jim Aguila, Manager
Substance Evaluation Section
Stationary Source Division

DATE: June 18, 2004

SUBJECT: APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS FOR SITES 8 AND 12 AT FORMER MARINE CORPS AIR STATION, EL TORO

This memorandum is in response to your request for any new California "Applicable or Relevant and Appropriate Requirements" (ARARs) not identified in 1997 for sites 8 and 12 at the former El Toro Marine Corps Air Station. Based on our previous memorandum dated May 12, 1997, we do not believe that there are any additional ARARs.

Rules and regulations of the South Coast Air Quality Management District (SCAQMD) should be included in the consideration of action specific ARARs. If you have not contacted the SCAQMD, we recommend that you contact Mr. Jay Chen, Manager, Toxics Section, at (909) 396-2664, to verify that there are no new local air district rules that should be considered as ARARs.

If you have questions, please call Mr. Lynn Baker of my staff at (916) 324-6997.

Rule 404 - Particulate Matter
This rule limits equipment from discharging particulate emissions in excess of 0.01 to 0.196 grain per cubic foot based on a given volumetric (dry standard cubic feet per minute) exhaust gas flow rate averaged over one hour or one cycle of operation. It excludes steam generators or gas turbines.

Rule 405 - Solid Particulate Matter
This rule limits equipment from discharging particulate emissions in excess of 0.99 to 30 pounds per hour based on a given process weight.

Rule 407 - Liquid and Gaseous Air Contaminants
This rule limits equipment from discharging carbon monoxide emissions in excess of 2000 ppm and sulfur dioxide emissions of 500 ppm or greater averaged over 15 minutes. It excludes stationary internal combustion engines, propulsion of mobile equipment or emergency venting.

Rule 408 - Circumvention
This rule prohibits a person from building, erecting, installing or using any equipment, the use of which reduces or conceals an emission which would otherwise constitute a violation of these rules or Chapter 3 (starting with 41700) of Part 4, of Division 26 of the Health and Safety Code.

Rule 409 - Fuel Combustion Contaminants
This rule limits the emissions of particulate matter from the exhaust of a combustion source (such as a gas turbine) to 0.23 grams per cubic meter (0.1 grains per standard cubic foot) at 12 percent CO2 averaged over 15 minutes. It excludes internal combustion engines.

Rules 431.1, 431.2, 431.3 - Sulfur Content of Gaseous, Liquid or Fossil Fuels
These rules limit sulfur compounds from combustion of gaseous fuels not to exceed 40 ppm, 0.05 percent by weight for liquid fuels and 0.56 pounds of sulfur per million BTU for solid fossil fuels.

Rule 474 - Fuel Burning Equipment-Oxides of Nitrogen
This rule limits the concentration of oxides of nitrogen (as NO2) averaged over 15 minutes, from any non-mobile fuel burning equipment, to a range of 125 to 300 ppm for gaseous fuels and 225 to 400 ppm for solid and liquid fuels depending on equipment size.

Regulation X - National Emission Standards for Hazardous Air Pollutants

This regulation implements the provisions of Part 61, Chapter I, Title 40 of the Code of Federal Regulations (CFR) under the supervision of the AQMD Executive Officer. It specifies emissions testing, monitoring procedures or handling of hazardous pollutants such as beryllium, benzene, mercury, vinyl chloride and asbestos.

Regulation XI - Source Specific Standards

Rule 1150 - Excavation of Landfill Sites
This rule states that no person shall initiate excavation of an active or inactive landfill without an Excavation Management Plan approved by the Executive Officer of AQMD. The Plan shall provide information regarding the quantity and characteristics of the material to be excavated and transported and shall identify mitigation measures including gas collection and disposal, baling, encapsulating, covering the material and chemical neutralizing.

Rule 1166 - Volatile Organic Compound Emissions from Decontamination of Soil
This rule limits the emissions of volatile organic compounds (VOCs) from contaminated soil to less than 50 ppm. For contaminated soil with 50 ppm or greater, an approved mitigation plan, describing removal methods and mitigation measures, must obtained from the District prior to proceeding with the excavation. Uncontrolled spreading of contaminated soil is not permitted.

Regulation XIII - New Source Review

This regulation applies to any new or modified equipment, which may cause the issuance of any non-attainment air contaminant, ozone depleting compound or ammonia. It requires all equipment to be constructed with BACT (Best Available Control Technology). For non-attainment emission increases, it requires the emission increases to be offset and substantiated with modeling that the equipment will not cause a significant increase in concentrations of non-attainment contaminants.

Regulation XIV - Toxics

Rule 1401 - New Source Review of Carcinogenic Air Contaminants
This rule specifies limits for cancer risk and excess cancer cases from new stationary sources and modifications to existing stationary sources that emit carcinogenic air contaminants. The rule establishes allowable emission inpacts for all such stationary sources requiring new permits pursuant to AQMD Rules 201 or 203. Best Available Control Technology for Toxics (T-BACT) will be required for any system where a lifetime (70 years) maximum individual cancer risk of one in one million or greater is estimated to occur. Limits are calculated using risk factors for specific contaminants.

Best Available Control Technology (BACT) Guidelines document

This document was compiled by SCAQMD. Although a guideline, it set up BACT requirements for various types of equipment or process. BACT is determined on a permit-by-permit basis based on the definition of BACT. In essence, BACT is the most stringent emission limit or control technology that is:

- found in a state implementation plan (SIP), or
- achieved in practice, or
- is technologically feasible and cost effective.

For practical purposes, at this time, nearly all AQMD BACT determinations will be based on achieved in practice BACT because it is generally more stringent than BACT based on SIP, and because state law constrains AQMD from using the third approach.

If you have any questions regarding these regulations, please call Mr. Ted Kowalczyk at (909) 396-2592.

Very truly yours

Jay Chen
Senior Manager
Toxics and Waste Management Unit

JC:CT:TK

cc: Carol Coy
Mohsen Nazemi

STATE OF CALIFORNIA—BUSINESS, TRANSPORTATION AND HOUSING AGENCY ARNOLD SCHWARZENEGGER, Governor

DEPARTMENT OF TRANSPORTATION
District 12
3337 Michelson Drive, Suite 380
Irvine, CA 92612-8894

Flex your power!
Be energy efficient!

June 22, 2004

Mr. Tayseer Mahmoud
Office of Military Facilities
5796 Corporate Avenue
Cypress, CA 90630

File: IGR/CEQA
SCH#: N/A
Log #: 1422
SR: I-5, 241 and 133

Subject: Request for Identification of Applicable or Relevant and Appropriate Requirements for Sites 8 and 12 at the Former Marine Corps Air Station (MCAS) El Toro, California

Dear Mr. Mahmoud,

Thank you for the opportunity to review and comment on the **Request for Identification of Applicable or Relevant and Appropriate Requirements for Sites 8 and 12 at the Former Marine Corps Air Station (MCAS) El Toro, California.** The project proposes the cleanup requirement of contaminated soil and treatment in the MCAS El Toro area.

Caltrans District 12 is a reviewing agency on this project, and has the following comments:

1. Since hauling trucks for removing contaminated soil will travel on the State transportation facilities, please spread the truck traffic during off peak periods to minimize the traffic operation impacts.
2. Hazardous materials should be transported and disposed of in conformance with Federal and State laws and regulations. Hazardous waste spill response plan and preventative measures, such as secondary containment, need to be established and implemented to control any accidents involving any spillage of hazardous materials on State transportation facilities.

Please continue to keep us informed of any future developments, which could potentially impact the transportation facilities. If you have any questions or need to contact us, please do not hesitate to call Lan Zhou at (949) 756-7827.

Sincerely,

ROBERT F. JOSEPH
Chief of IGR/Community Planning Branch
District 12

DTSC
JUN 2 8 2004
CYPRESS

c: Terry Roberts, Office of Planning and Research
Terri Pencovic, Caltrans HQ IGR/Community Planning

"Caltrans improves mobility across California"

Appendix D
Responses to Comments on Draft Final FS Addendum

Document Title:

(1) Draft Final Feasibility Study Addendum, Operable Unit 3A, IRP Site 8, Former Marine Corps Air Station El Toro, California, July 2005.

Reviewer: Ms. Deirdre Dement, Associate Health Physicist, Environmental Management Branch, California Department of Health Services; comments dated 20 September 2005

Comment No.	Section/ Page No.	Comment	Response
GENERAL COMMENTS			
1.		The document indicates that default parameters from EPA's PRG Calculator were used rather than the default parameters from the NRC's DandD dose model to calculate the dose. DHS needs an explanation of why these default parameters are more applicable to the site than the NRC's dose model default parameters. For example, there are large discrepancies between the consumption rates presented as the default values from EPA's risk model and the NRC's DandD dose model. The Navy needs to justify the values it used based on standardized data from a reference rather than simply specifying that the default values from EPA's risk model were used. If model parameter choices are explained relative to site specific conditions, DHS would consider the proposed changes from the NRC DandD default values. For example, site specific conditions might affect the probability of home-grown products being consumed.	Based on the discussion with DHS in the Base Realignment and Closure (BRAC) Cleanup Team (BCT) meeting on 20 December 2005, RESRAD computer code has been used for dose assessment at IRP Site 8. The default exposure pathways for a resident farmer scenario (with an exception of inhalation of radon and its decay product) at IRP Site 8 are used in the RESRAD model. Site-specific exposure pathways and parameters for an Orange County resident are not used in dose modeling.

Document Title:

(1) Draft Final Feasibility Study Addendum, Operable Unit 3A, IRP Site 8, Former Marine Corps Air Station El Toro, California, July 2005.

Reviewer: Ms. Deirdre Dement, Associate Health Physicist, Environmental Management Branch, California Department of Health Services; comments dated 20 September 2005

Comment No.	Section/ Page No.	Comment	Response
SPECIFIC COMMENTS			
1.	Appendix B, Page B-2, Section 4	Please explain further how the geographical setting and average behavior of an Orange County Resident would affect the use of NRC default parameters.	The issues of geographical setting and average behavior of an Orange County Resident are no longer relevant since RESRAD dose model has been used for the dose assessment at IRP Site 8. The default exposure pathways for a resident farmer scenario (with an exception of inhalation of radon and its decay product) at IRP Site 8 are used in the RESRAD model. Site-specific exposure pathways and parameters for an Orange County resident are not used in dose modeling.
2.	Appendix B, Page B-3, Section 4	As noted in General Comment 1 above, there appear to be large discrepancies between the EPA's Risk Calculator model parameters and NRC's dose model parameters. Please provide information and references that would justify changing the NRC's default parameters to the lower amount of food ingested per year assumed by EPA's model.	Please see response to General Comment #1.

Document Title:

(1) Draft Final Feasibility Study Addendum, Operable Unit 3A, IRP Site 8, Former Marine Corps Air Station El Toro, California, July 2005.

Reviewer: Ms. Deirdre Dement, Associate Health Physicist, Environmental Management Branch, California Department of Health Services; comments dated 27 and 31 October 2005

Comment No.	Section/ Page No.	Comment	Response
GENERAL COMMENTS			
1.		Show me the information, and source, calculations, etc. you used for determining the "average Orange County resident" and the "average behavior of an Orange County resident." Did you use information from a study or printed data. If so, please provide this for our review. Were the consumption rates of home produced fruit, vegetables, etc. lower for Southern California, than other parts of the country?	The issues of "average Orange County resident" , "average behavior of an Orange County resident" and consumption rates for home produced fruit and vegetables are no longer relevant because the RESRAD dose model as presented in the attached Appendix B will be used for the dose assessment at IRP Site 8. This appendix will be included in the next version of the FS Addendum submitted for DHS's review. As explained in the updated Appendix B, the default exposure pathways for a resident farmer scenario (with an exception of inhalation of radon and its decay product) at IRP Site 8 are used in the RESRAD model. Site-specific exposure pathways and parameters for an Orange County resident are not used in dose modeling (see response to Comment #5).
2.		How would the average Orange County resident compare to a residential farmer?	An average Orange County resident at Former MCAS El Toro is regarded as a suburban resident. Former MCAS El Toro is located near the eastern edge of the City of Irvine in Planning Area 51. A review of zoning ordnance of the City of Irvine for Planning Area 51 shows that the area in the immediate vicinity of Site 8 is zoned for institutional, transit oriented development, and recreational use (see zoning ordinance map on Page 3). Other zoning districts in Planning Area 51 include low- and medium-density residential. Therefore, a reasonably foreseeable exposure scenario for dose modeling for unrestricted release of IRP Site 8 is a suburban resident scenario. A suburban resident is unlikely to have a subsistence farm as would be the case for a residential farmer. In accordance with the RESRAD User's Manual (Yu et al. 2001), the exposure pathways for a suburban resident include: • Incidental ingestion of soil • Inhalation of particulates emitted from soil • External exposure to ionizing radiation • Ingestion of homegrown fruits and vegetables grown in the contaminated soil Since there are fewer exposure pathways for a suburban resident, compared to a resident farmer, the dose to a suburban resident is less.
3.		For the EPA's default parameters, are the parameter defaults for consumption values dry weight or wet weight? Also, explain why the EPA's default values were smaller in comparison to the NRC's default consumption values.	A clarification received from EPA Superfund Office on 21 December 2005 indicated that EPA's consumption rates are based on dry weight. However, as explained in the last paragraph on Page B-3 of Appendix B of the Draft Final FS Addendum, the use of the NRC default consumption rates for fruits and vegetables would result in a TEDE of less than 25 mrem/year for the exposure pathways considered relevant to a residential receptor at IRP Site 8 in the Draft Final FS Addendum.

Document Title:

(1) Draft Final Feasibility Study Addendum, Operable Unit 3A, IRP Site 8, Former Marine Corps Air Station El Toro, California, July 2005.

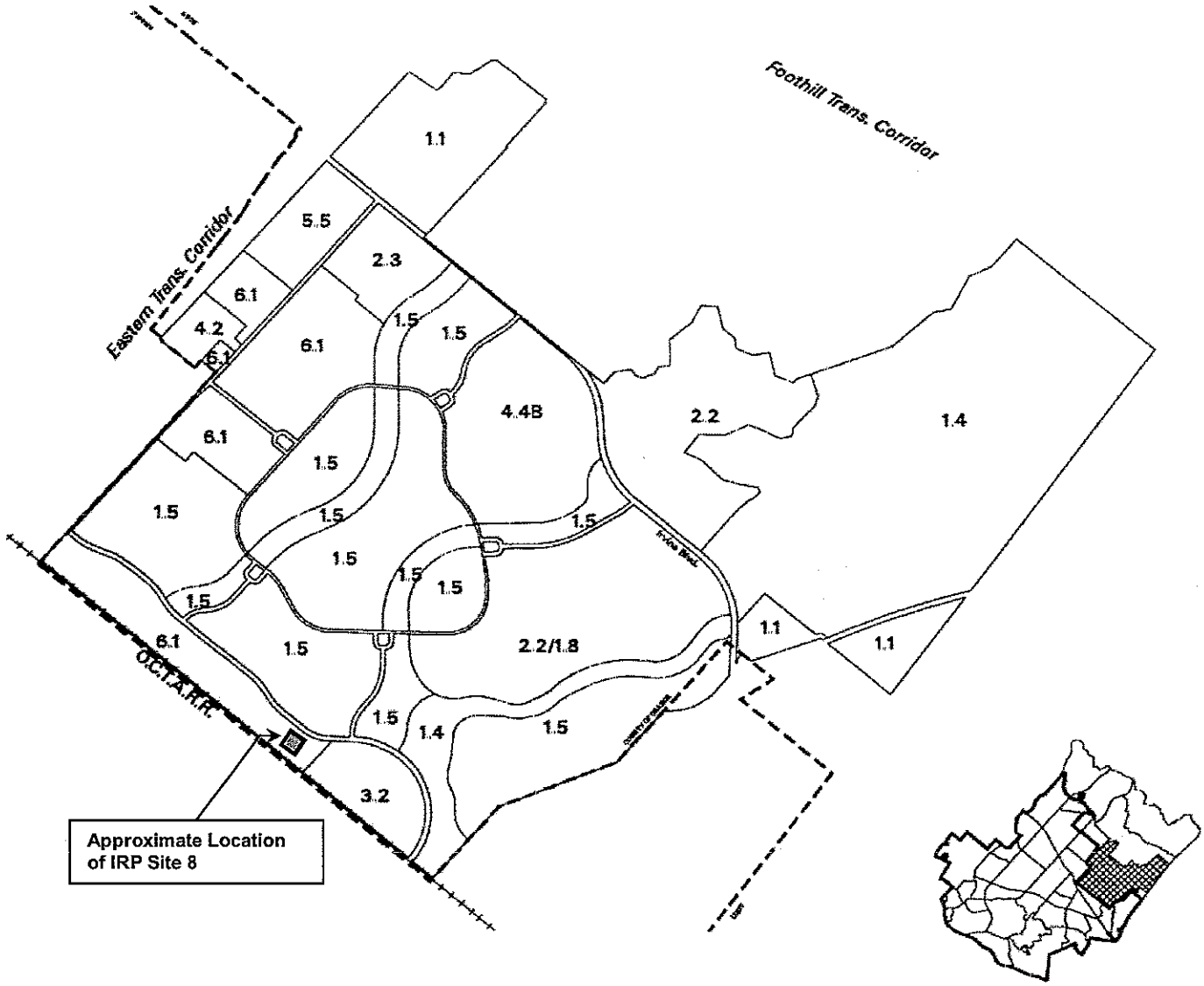
Reviewer: Ms. Deirdre Dement, Associate Health Physicist, Environmental Management Branch, California Department of Health Services; comments dated 27 and 31 October 2005

Comment No.	Section/ Page No.	Comment	Response
4.		What are the sources of drinking water and water for irrigation at El Toro sites?	Presently shallow groundwater is not used as a source of drinking water or for irrigation water at Former MCAS El Toro. Municipally supplied water is used for drinking and irrigation purposes. Based on urban/suburban setting of Former MCAS El Toro, future residents are likely to use municipally supplied water for drinking or irrigation. Shallow groundwater is not expected to be used for either purpose.
5.		Have you tried running 1 pCi/g in soil through RESRAD? You may want to try this (using RESRAD's default parameters.)	Navy used the RESRAD computer code (version 6.3) to assess the dose at IRP Site 8, based on a Ra-226 concentration of 1 picocurie per gram (pCi/g) above background in soil. The assessment included the default exposure pathways (external gamma, inhalation, plant ingestion, meat ingestion, milk ingestion, aquatic foods, drinking water, and soil ingestion) with the exception of inhalation of radon and its decay product. Exposure parameters were set to their default values except the area and thickness of contamination. The area of contamination was set to a value equal to the area encompassed by IRP Site 8, Units 1 and 4 (approximately 5,670 square meters) and the thickness of contamination was set at 0.5 meters. This simulation resulted in a total maximum dose of 9.0 mrem/y at 5. 4 years. If the default exposure parameters were used (area of 10,000 square meters and thickness of contamination of 2 meters), the maximum dose is 14.6 mrem/y at 49.8 years. Based on the discussion with DHS on 20 December 2005, RESRAD will be used for the dose assessment at IRP Site 8 in the Final FS Addendum. An updated Appendix B to the Site 8 FS Addendum with dose modeling using RESRAD code is attached to these RTCs.

Reference:

Yu, C.; Zielen, A.J.; Cheng, J.-J.; LePoire, D.J.; Gnanapragasam, E.; Kamboj, S.; Arnish, J.; Wallo III, A.; Williams, W.A.; and Peterson, H. 2001. *User's Manual for RESRAD Version 6.* Environmental Assessment Division, Argonne National Laboratory (ANL/EAD-4). July.

ZONING ORDINANCE MAP
PLANNING AREA 51



OVERLAY ZONE

ZONE #	ZONING DISTRICT	ZONE #	ZONING DISTRICT
1.1	Exclusive Agriculture	3.2	Transit Oriented Dev.
1.4	Preservation	4.2	Community Commercial
1.5	Recreation	4.4B	Commercial Recreation
2.2	Low-Density Residential	5.5	Medical and Science
2.3	Medium-Density Residential	6.1	Institutional